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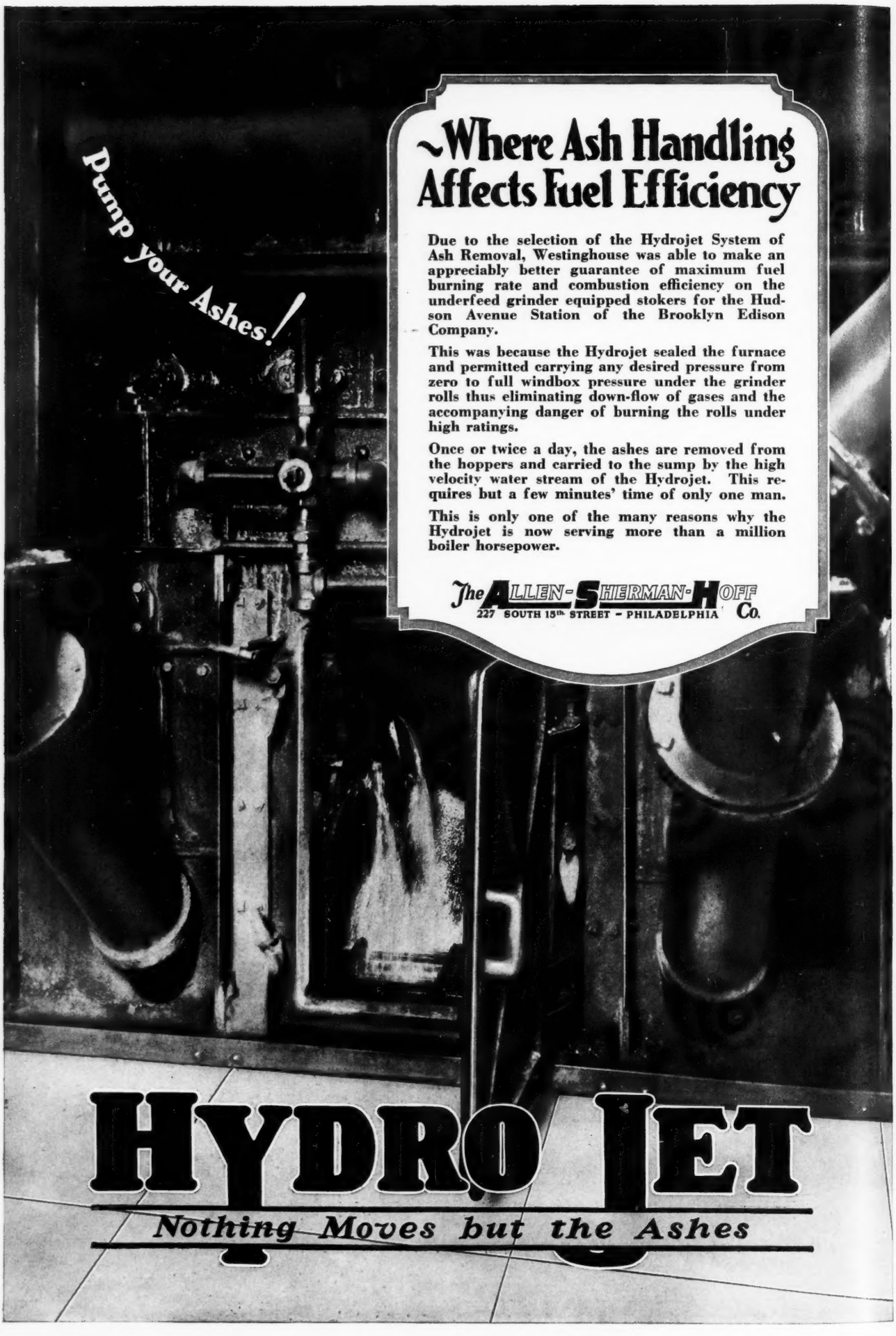
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Volume 69 Number 13

March 26, 1929

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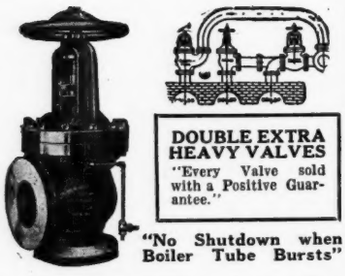

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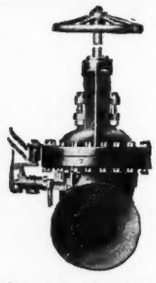

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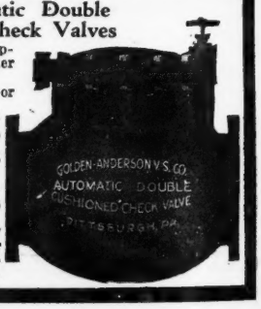

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POWER

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The Physical Properties of Steam

WITH the recent rapid advance in the pressures and temperatures at which steam is used, a knowledge of its heat content, pressure-temperature relations, specific volume, etc., under conditions beyond the range of existing steam tables became necessary.

Prof. Hugh L. Callendar, of the Imperial College of Science, has for several years been engaged upon such an investigation for the British Electrical and allied Manufacturers Association. Prof. Oscar Knoblauch, of Munich, and other investigators have been making experimental determinations and numerous mathematical physicists have been trying to co-ordinate and rationalize their results.

Some three years ago, under the inspiration of George A. Orrok, a committee was formed in this country to prosecute such an investigation. The measurement of the Joule-Thomson effect was assigned to Dr. Harvey N. Davis, the Davis of the Marks-Davis steam tables, then at Harvard. Dr. Frederick G. Keyes, of M. I. T., was asked to determine the pressure-volume-temperature relation. Direct measurement of specific heat and latent heat was assigned to the United States Bureau of Standards.

The difficulties of such a pursuit of the elusive heat unit, the accurate measurement of small volumes, high pressures and temperatures under varying conditions are extreme. It is not surprising that there should not be entire agreement in the results or that they should not precisely agree with the indications of molecular physics.

The profession wants and needs standard charts and tables of these properties, or at least sufficiently numerous determinations from which curves can be drawn, formulas deduced and tables computed.

The determination of these points should engage the best research talent, the most ingenious and refined apparatus and the analysis and deduction of the ablest physicists that present world-wide knowledge, experience, skill and facilities afford.

For a particular property under a given set of conditions there can be but one correct value. It would be a great thing for science and for the engineering profession if all the outstanding workers in this field from all over the world could be brought together for a comparison of methods and results, an analysis of their differences and their probable causes.

If agreement upon a set of values could be arrived at by such a conference of experts, we should have a basis worthy of international acceptance on which each country or organization could predicate its own formulas, diagrams and tables upon whatever co-ordinates, in whatever units and with whatever arrangement it desired.

F. R. Low

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2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Distribution Not Generation the Key to Low Cost Power

GOVERNOR ROOSEVELT'S power-control recommendations to the New York State Legislature are reminiscent of ex-Governor Smith's ideas. The Governor proposes that the development of the St. Lawrence River hydro-electric resources shall be made by a board of five trustees to be known as "The Trustees of the St. Lawrence River," to be a corporate instrumentality of the state. This board is in many ways similar to the Power Authority proposed for the same purpose by the Governor's predecessor.

Governor Roosevelt is very explicit that not only shall the water powers forever remain the property of the people of the state, but also that the structures necessary for their development shall be built and operated by the state. Governor Smith's proposal did not go quite as far as this, particularly regarding public operation. The power developed under the proposed plan is to be transmitted and distributed, if possible, by private capital and agencies at rates that will assure fair and impartial treatment to all consumers.

The trustees are to receive no salary, but each shall be paid reasonable expenses. The proposed legislation also appropriates one hundred thousand dollars to be paid out on vouchers signed by the chairman of the trustees. The plan proposes that the trustees shall have power to issue tax-exempt bonds, but not to pledge the credit of the state. All this is to be done to retain the water powers in public control and to distribute cheap power to the people of the state.

Niagara Falls is the only water-power development in the state comparable with that proposed for the St. Lawrence. At Niagara Falls the development has been made by private capital. The company pays heavy taxes to the nation, the state, and to the city of Niagara Falls, besides other charges for the privilege of doing business. The income from the company's securities is also taxable by the state. While paying these charges, from which state operation would be exempt, the Niagara Falls Power Company sells the total output of its plants for an average rate of 2.8 mills per kilowatt-hour.

Taking everything into consideration, the Governor, with his plan of tax-exempt securities and a board of trustees to serve without salary, cannot hope to wholesale power to the transmission and distribution companies at much less than is now being done at Niagara Falls by a private corporation. The Governor seems to have overlooked that the cost of power generation is in general only a small part of the total cost of delivering it to the ultimate consumers. If an answer to the problem of lower power cost to the utlimate consumer is to be found, then it must come through reduced transmission and distribution costs. Apparently the Governor has attacked the problem at the wrong end. This problably makes little difference, since his plan must have legislative approval before it becomes effective. If the past action of that body is an indication of its future attitude toward the state going into the water-power business, the Governor's plans will act only to obstruct these developments.

Inspection of Steam Power and Heating Plants

THERE are now before the legislature of the State of New York two amendments to the labor law. One has to do with the inspection of steam power and heating plants and the other with low-pressure boilers in cities of over a million population.

It is too early to determine what is back of these amendments, but there seems to be much that is objectionable to both steam power and heating interests, and active opposition has been started by the American Society of Heating and Ventilating Engineers.

The first amendment would establish a new division of the Department of Labor that would have authority to prepare specifications and codes for the installation or alteration of steam power and heating plants, to approve plans for new installations and to inspect both new and old plants once each year. The inspectors are to be drawn from journeymen steam and pipe fitters of at least ten years' experience. Registration of master steam fitters is also provided for.

Power has always advocated the inspection of boilers by competent inspectors as necessary to public safety. But the present amendment goes further than this and subjects the complete plant layout to such supervision. It is questionable whether engineers will welcome such supervision. No provision has been made for authorizing insurance inspectors to act as state inspectors of the boilers as is done in many states.

The other amendment, applicable only in New York City, is evidently intended as a health measure in preventing the operation of low-pressure boilers that permit the escape of fuel gas into the building. As now worded it applies only to coal-fired steam boilers. If it is to be effective, it should be changed to include hot-water water boilers and hot air furnaces fired by any of the fuels now in use.

The opposition that these amendments have encountered will no doubt bring out at the first public hearing the reasons for their proposed enactment.

Better Use of Byproduct Power

STEAM pressures show a definite upward trend in the industrial plant. True, industrial plants carrying pressures above five hundred pounds are still very few, but there has been a big gain in the range from three hundred to five hundred pounds. Here the paper industry has taken the lead, but other process industries are following suit.

As has repeatedly been pointed out, the problem of high steam pressures is one thing in the central station and quite another in the industrial plant. Except for local variations in plant size, fuel quality and cost, capacity factor and temperature of condensing water, the central station presents a fairly constant problem.

It is merely necessary (assuming equal reliability) to choose that pressure which gives the lowest cost per kilowatt. At present it is generally agreed that a central station operating at six hundred pounds, with its necessary equipment for reheating the steam, costs more per kilowatt than a four hundred-pound station. It is also pretty well agreed that the still more efficient twelve-hundred-pound station costs less than a six-hundred-pound station. Moreover, the four-hundred-pound station lends itself better than the six-hundred-pound to future enlargement by the addition of a twelve-hundred-pound section. It therefore appears likely that few new six-hundred-pound central stations will be built, the choice lying between four hundred and twelve hundred pounds (or higher).

Industrial plants, on the other hand, will have no such simple choice of pressure ranges. Three things, at least, distinguish the case of the industrial plant from that of the central station—the general lack of condensing water, the need for heating and process steam and the definite limit to power production as fixed by the manufacturing power demand. The combined effect of these three factors is to fix rather definitely the economical pressure for any given plant, but to make the pressure that is ideal for one entirely unsuitable for another. Incidentally, an increase from four hundred to six hundred pounds in the industrial plant does not necessarily involve any large increase in investment, because the high back pressure makes reheating unnecessary at the higher boiler pressure.

As dependable equipment for all pressures becomes more available, it will be customary for industrial plants to choose the pressure that permits generating the existing power demand as a byproduct of the process-steam demand. According to the relation of the two demands, this may vary all the way from two hundred to two thousand pounds. It will thus happen that the range of justified pressures in industrial plants will start lower and reach higher than that in the central-station field and that it will include the entire range between four hundred and twelve hundred pounds, where, according to present indications, comparatively few new central-station installations will be made.

Industrial plants carrying the proper pressure to generate the local power demand as a byproduct frequently produce electricity at very low cost. An example is the Ajax Rubber plant, described in this issue. Including every fixed and operating charge this four-hundred-pound installation, operating at one-third capacity, will generate current for 0.66 cent per kilowatt-hour. At full load, which will be approached in a few years, this cost will fall to 0.36 cent. The clear analysis of the chief engineer will guide other engineers in a scientific approach to their individual power problems.

Problems of Modern Boiler Design

BOILER design has progressed rapidly since the early days of return tubular and locomotive type boilers. The demands of high pressure, high superheat, high ratings and high efficiencies have developed new problems to tax the skill and ingenuity of designers. In fact many of these problems have not yet been completely and satisfactorily solved.

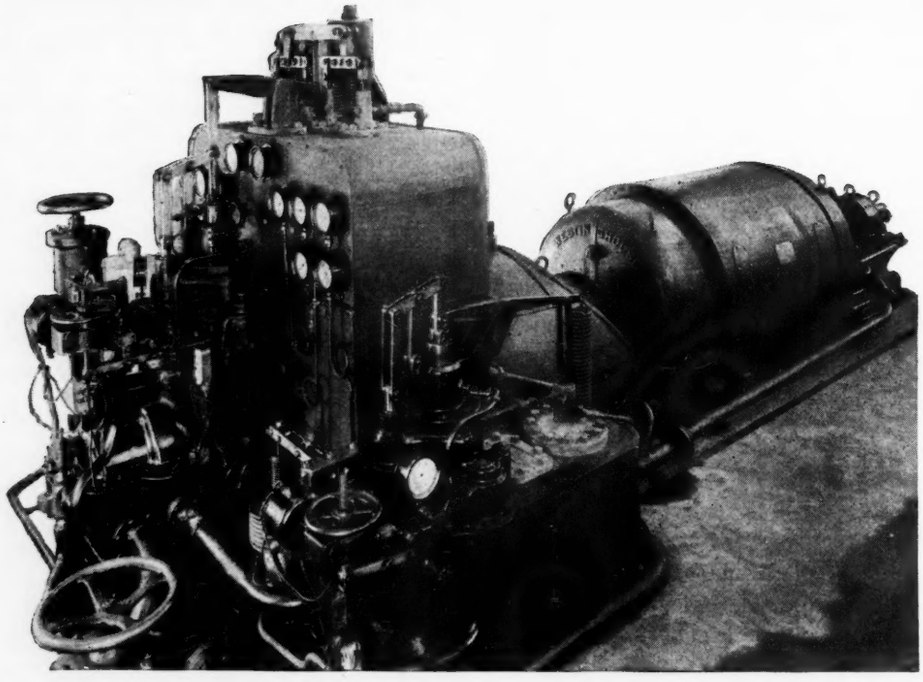
Designs for boiler pressures up to fifteen hundred pounds now seem to be well developed. Above that pressure there does not seem to be any unanimity of opinion. The Loeffler, Benson, Schmidt, Brown Boveri, and other designs show wide differences in principles and details. Only experience will indicate which of these types will become dominant.

Higher steam temperatures have led to the introduction of many new alloy steels. Here again experience alone can indicate which is most suitable for boiler piping and superheater construction. Another problem is the determination of the character of superheating surface, whether convection, radiant or a combination of these. When this is settled the location and size of superheater surface presents additional problems. Little exact data are available regarding heat transfer under varying conditions of furnace operation, and more would be welcomed.

High ratings require rapid evolution of large quantities of heat in the furnace and hence high flame temperatures must be produced if economy is to be maintained. This leads to water-wall construction. What types of water-walls will eventually be best and what proportions of water-wall surface and convection surface should be installed?

High efficiencies can be maintained when flue gas temperatures are low. What are the permissible lower limits of flue gas temperature with various fuels? Then the designer must face the problem of whether air preheaters or economizers or both shall be used. If steaming economizers are to be used, what will be the relative proportions of convection boiler surface, economizer surface and air preheater surface that give lowest first cost and lowest operating costs?

These recent developments in boiler equipment have introduced new problems on which there is not only a lack of data but a confusion of ideas regarding the best solution. A thorough discussion of these problems will be welcomed by power engineers.



High-back-pressure turbine, 1,500 kw., bleeding at 170 lb. and exhausting at 85 lb.

High Pressure Turbine Furnishes CHEAP POWER

In Ajax Rubber Plant

By K. W. Karlson
Chief Engineer, Ajax Rubber Company, Inc.

Remodeled plant, using new 425-lb. boiler and 1,500-kw. turbine bleeding at 170 lb. to the station header and exhausting at 85 lb. to process, makes possible a power cost per kilowatt-hour ranging from 0.663c. at one-third capacity to 0.358c. at full load. Control system provides adjustable constant flow to turbine throttle. Process steam under back-pressure control.

ENGAGED in the manufacture of automobile tires and tubes, and such accessory products as go with this line, the Ajax Rubber Company, of Racine, Wis., has enjoyed a continuous growth throughout the entire period of its existence. During that time a power plant adequate for all purposes, including that of generating all electric power, has been maintained. To meet the increasing demands upon it, the power plant has grown from one consisting of two small hand-fired boilers and two small generators, directly connected to Corliss engines, in 1911, to its present proportions.

A brief review of the evolution of the plant will lead to a better understanding of the development just completed. In 1913-14, one 5,000-sq.ft. Stirling boiler and one 750-hp. Corliss engine were added. The boiler was set for hand-firing alongside of the original boilers, and the engine was arranged for direct drive of fourteen rubber mills. In 1915-16, further additions, consisting principally of switchboard equipment, synchronous condenser, etc., were made.

By 1917 continued increase in power demand made necessary increased boiler capacity. In view of the inadequacy of the old plant, both as to capacity and efficiency, it was considered unwise to make further additions to it. Plans were approved for an entirely new boiler room, calling for an addition to the building,

of modern steel and brick construction, provided with adequate basement and superstructure for coal and ash bins. In this addition two 5,000-sq.ft. boilers equipped with 6-retort, 17-tuyere underfeed stokers, forced-draft equipment, superheaters, etc., were installed and connected to the existing piping system. Furnaces were designed and boilers set to operate at 150 per cent rating.

When these boilers were ready, the entire load was transferred to them. The old portion of the boiler plant was dismantled, the two original boilers discarded and the building rebuilt to conform to the design of the new addition. The original Stirling boiler was reset and equipped identically with the two new boilers.

In addition, coal and ash handling machinery, consisting of a track-hopper, an apron conveyor to carry the coal from the hopper to a crusher, a pivoted-bucket carrier and coal and ash bins were provided. In 1919, another 5,000-sq.ft. boiler completed the second battery, and at this time a fuel economizer with induced-draft fan equipment and a new chimney were added. By this time the capacity in the engine room had been outgrown, and means for meeting new demands were called for.

Mixed-Pressure Turbine Uses Surplus Exhaust

As on previous occasions, purchased power was considered. The plant was now fairly efficient, particularly in the boiler room, and as a whole it was about holding its own when the prevailing unit cost was compared with rates offered by the utility. Accordingly, the purchase of power did not appear advisable, even when considered in conjunction with the proposed increase in capacity.

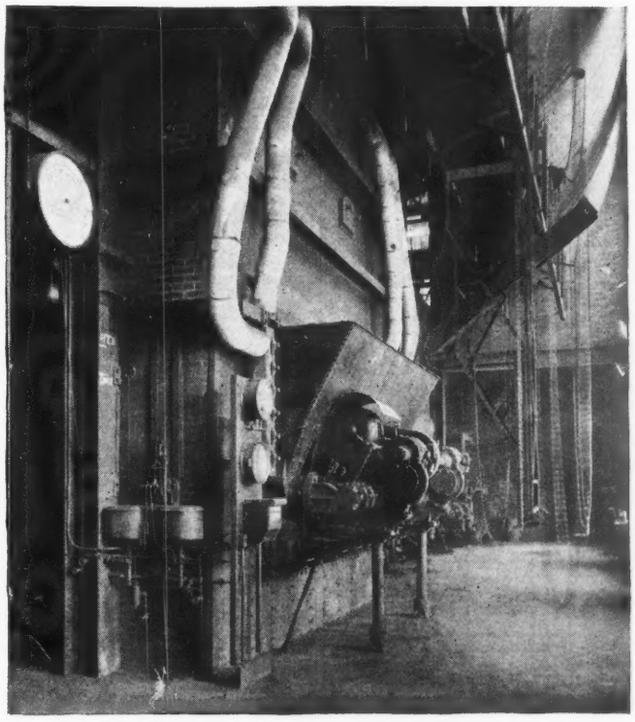
Equipment in the engine room consisted of three Corliss-engine generating units, a Corliss pumping engine and an assortment of other steam-driven equipment, all operating noncondensing and resulting in a considerable surplus of exhaust steam. This condition offered an opportunity for the generation of some power, more or less in the nature of a byproduct. Accordingly, the smaller of the Corliss generating units was replaced by a 1,250-kw. mixed-pressure turbine generator, equipped with surface condenser and auxiliaries, including a combination forced-and-natural-draft cooling tower. This arrangement offered an opportunity for such savings that the purchase of power to meet the new requirements could no longer be considered. Although the capacity of the new equipment was much in excess of that required, making it necessary to operate it at fractional load for a considerable period, the savings effected paid handsome returns on the investment.

Having reached this stage in its development, the plant was continued in operation, with only minor additions and alterations, until 1927. During this period the load had increased until all equipment available was loaded to full capacity. At this time word was received that the factory output was to be increased about 75 per cent, this increased production to be effective as soon as necessary buildings and equipment could be made available. The amount of additional electric power to be furnished was considerable, and to increase the plant capacity to provide it would involve a large investment, so that the advisability of purchasing power was again considered.

Anyone familiar with the tire-making industry knows that the demand for electric power is only a portion of the services required from the power plant, its ratio to other services varying with the nature of the goods manufactured and with plant conditions. With the present set-up of this plant, less than 40 per cent of the total is chargeable to electric-power generation. The balance of the cost applies to steam-driven direct drives, process steam, and a variety of other steam-driven equipment.

The proposed program called for a large increase in the demand for process steam. Up to this time such steam had been supplied direct from the boilers through a reducing valve, and the new requirements were such that addition to the boiler plant would be necessary regardless of the plan adopted. It thus developed that either plan called for a considerable investment, that providing for privately generated power being the larger.

When finally developed, the plan for private generation proposed the installation of an 8,000-sq.ft. boiler to carry a steam pressure of 400 lb., the steam at such pressure to be taken by a 1,500-kw. high-back pressure turbine of the bleeder type, the exhaust steam at 85 lb. pressure to be used for process, and the steam bled to be carried to the original station header in which a pressure of 170 lb. is carried. This program also included considerable auxiliary equipment. Purchased power would have called for a similar boiler built for 200 lb. pressure, a substation, and considerable auxiliary equipment.



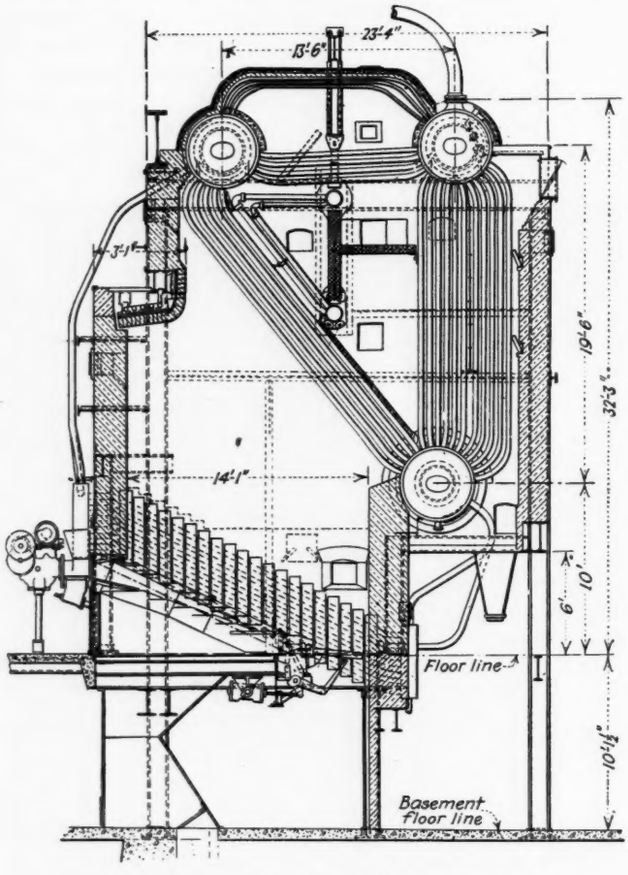
Front of new boiler equipped with motor-driven eight-retort underfeed stoker

Final adoption of the plan for privately generated power was decided upon only after exhaustive study. Again the power made available was in the nature of a byproduct, and, notwithstanding the fact that the final set-up was such that minimum cost would not be available at the outset, the plan nevertheless was sufficiently attractive to practically force its adoption.

There were two methods of carrying out this plan. Providing adequate capacity to meet the new requirements, and no more, would require a minimum investment covering a comparatively small boiler and a 750-kw. straight-back-pressure turbine with the necessary auxiliary equipment. This method contemplated operating the new high-pressure boiler to meet the requirements of process steam only, the turbine to deliver whatever power would be available in expanding this steam from 400 lb.

and 600 deg. F. to 85 lb. Besides requiring a lower investment, this method would have the advantage of providing a fair load for the old boilers, which condition together with that of operating the new equipment at or near its rated capacity, would offer excellent overall economy.

The second method called for a boiler of as large capacity as could be accommodated in the available space and a 1,500-kw. turbine of the combination back-pressure and bleeder type. Such an installation would provide excess capacity for future extension. It had the disadvantage, however, of requiring a larger investment, and, owing to the more or less unfavorable load condition that would exist, at the beginning, the highest economy would not be obtained. With the unit fully loaded, however, the advantages were such that this plan was adopted.



Section through 425-lb., 8,000-sq.ft. boiler

425-lb. Boiler Installed

The boiler installed is of Wickes three-drum bent-tube type, built for a working pressure of 425 lb. and having 8,000 sq.ft. of steam-making surface. It is equipped with an 8-retort 33-tuyere Taylor stoker, American Engineering Company water walls, Detrick suspended arch, Foster superheater, Diamond soot blowers, a Swartwout S.C. feed-water regulator, and Hagan combustion control. The unit is designed and set for continuous operation at 300 per cent of rating. It is connected to the common station breeching, allowing the escaping gases, together with those from the older boilers, to pass through the cast-iron economizer previously mentioned.

This arrangement results in an average temperature of about 300 deg. F. in the gases going to the chimney. The forced- and induced-draft equipment provided for the older boilers, also serves the new boiler. The feed water is taken from two open heaters by one of two 2-stage centrifugal motor-driven pumps, and forced through the economizer at a pressure of 200 lb. In the line leaving the economizer, two additional boiler-feed pumps are installed, taking the water coming from the economizer at a pressure of 200 lb. and about 300 deg. F. and boosting it to a pressure of 500 lb. for the new boiler. Between these latter pumps and the economizer, a lead is taken off for feeding the old boilers. This somewhat complicated method of boiler feeding was made necessary owing to the presence of the cast-iron economizer.

Turbine Bleeds at 170 lb. and Exhausts at 85 lb.

The turbine is a Westinghouse combination impulse and reaction machine equipped with a back-pressure regulator set for 85-lb. pressure and arranged for bleeding steam at 170 lb. pressure. It is directly connected to an 1,875-kva. alternator and exciter. The steam taken by the turbine at 400 lb. is expanded to 85 lb. exhaust pressure for use in process, the variation in demand for such steam being taken care of by the functioning of the back-pressure regulator. Steam bled at 170 lb. pressure and about 475 deg. F. is carried to the old station header and is used for driving steam-driven equipment operating at this pressure.

Normally, a turbine of this kind probably would be equipped with a bleeder pressure control in addition to the back-pressure control. The demand upon the high-pressure boiler in such case would be the sum of the two demands. It would vary directly as the combined requirement of the two services, and the total demand for 170 lb. steam would be met by the operation of two systems; that of the bleeder pressure control of the turbine and the combustion controls of the low-pressure boilers. Anticipating difficulty with this arrangement, it was conceived to so arrange the governors on the turbine as to provide a constant flow at the throttle, such flow to be set for any desired value simply by adding or removing weights.

This arrangement provided that the part of the throttle flow not required by process would pass out through the extraction line non-automatically. The amount of steam bled would thus vary inversely as that taken by process, and the control of the demand for 170 lb. steam would remain with the combustion controls on the low-pressure boilers. This arrangement also provided the means of operating the high-pressure boiler at a base load and at the most economical rating, it being within the control of the operator to adjust the equipment for such rating.

The reasons that influenced the engineers to call for a machine arranged for bleeding at the comparatively high pressure of 170 lb. were two-fold:

First, by being able to bleed, the amount of electrical output by the machine was, within certain limits, placed within the control of the operator. With a straight back-pressure machine the electrical output would be governed entirely by the demand for process steam. Since this demand varies within wide limits, the minimum frequently being so low that no power would be generated by this unit, excessive peaks would, at such times, occur on the units operating in parallel with it. In the case of a bleeder turbine, this condition is largely eliminated, since the electrical output of the machine within certain limits comes within the control of the operator, as with a given throttle flow there will be only a comparatively slight variation in output, as the ratio between the quantities of process steam and bled steam changes.

Second, in the event that the plan of remodeling into a 400-lb. plant, with the consequent discarding of the present low-pressure boilers, materialized, the entire demand of 170-lb. steam could be provided for by extraction from the high-pressure turbine. In such case the machine would be equipped with a bleeder pressure control. With this development the turbine will operate at or near its rated capacity and the full benefit of the low cost incident to the generation of byproduct power will be available.

Byproduct Power at Low Cost

The new equipment has been in operation for about six months and aside from some minor difficulties, the most serious of which has been that of properly conditioning the feed water, the operation has been successful and anticipated results as regards reliability, economy and unit cost have been obtained. Power costs are low and will become lower.

Power is now being generated at a cost of 0.66c. per kw.-hr., with the turbine operating at about one-third of its capacity and the boiler at 167 per cent of its rated capacity. The cost is calculated on the basis of these ratings and on the basis of an outage of 105 days per year, or 29 per cent. It includes all items of expense classified as cost of steam, fixed charges and operating costs.

To determine the cost of steam, fixed charges, operating costs and the cost of fuel are expressed in cents per 1,000 lb. of water evaporated. Fixed charges include 16 per cent of the total cost of the boiler and all auxiliary equipment and such portion of the fixed charges (at prevailing rates) on the old plant as should properly be charged against the output of the new boiler. The item of operating costs includes administrative expense, that of labor, materials and supplies, the cost of operating all auxiliary equipment, insurance (direct damage, use and occupancy, fire, and workmen's compensation) taxes and light. The portion of the total cost of these items distributed over the output of the new boiler bears the same ratio to the total cost as the output of this boiler bears to the total output.

Fuel is being purchased on the basis of 20.5c. per 1,000 lb. of steam from and at 212 deg. F. The cost of 1,000 lb., as actually evaporated by the boiler, is 23.06c.

When calculated as outlined the cost of steam is as follows:

	Cents per 1,000 Lb.	Per Cent
Fixed charges	8.35	21.6
Operating costs	7.15	18.5
Fuel	23.06	59.9
Total	38.56	100.00

As produced by the high-pressure turbine, the cost per kilowatt-hour is found to be:

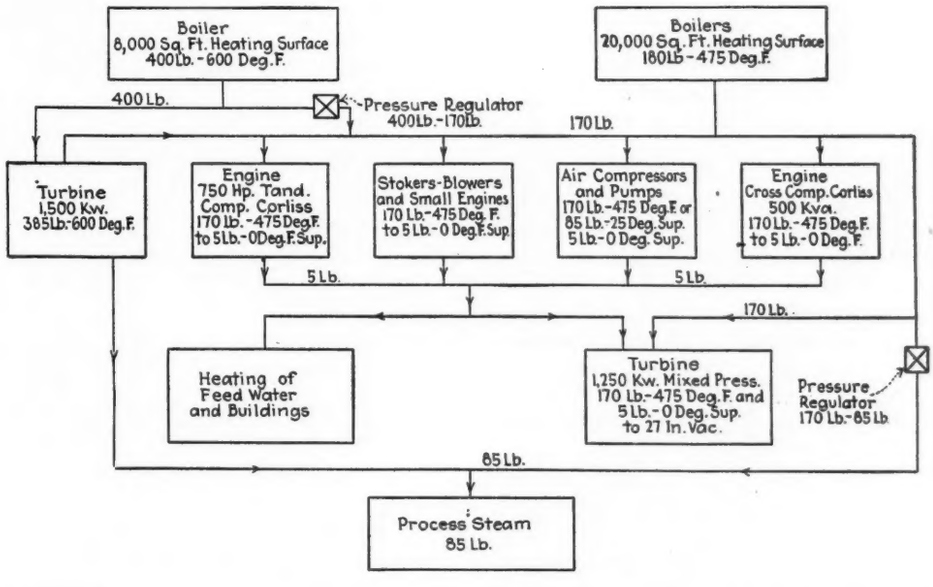
	Cents per Kw.-Hr.	Per Cent
Fixed charges	0.345	52.1
Operating costs	0.125	18.9
Cost of steam	0.193	29.0
Total	0.663	100.0

For fixed charges in this case 16 per cent of the total investment for turbine and auxiliaries, including such portion of the fixed charges on the old equipment as can properly be charged against the turbine output, is taken. Operating and maintenance costs are taken from actual experience.

The amount of steam charged to the electrical output of the turbine bears the same ratio to the total passing through it as the heat removed from this steam bears to the total heat in the original steam at the rating given. The heat removal amounts to approximately 5 per cent. The figures given are taken from plant records and represent results obtained with present load conditions.

When this turbine is loaded at or near its capacity, the heat removal will amount to approximately 8.9 per cent and the cost per kilowatt-hour, based on the same operating schedule as in the previous case, will be.

	Cents per Kw.-Hr.	Per Cent
Fixed charges	0.120	33.6
Operating cost	0.043	12.0
Steam	0.195	54.4
Total	0.358	100.0



Steam-flow diagram for entire plant

The foregoing figures are all based on an operating schedule of 24 hours per day, which is the prevailing schedule in the plant throughout the year, and applies to the new high-pressure equipment only. Decreased load on the low-pressure boiler plant, resulting from the adding of the high-pressure equipment, tends to raise the cost of steam delivered by these boilers. Departure from former practice in power-plant design to obtain advantage of byproduct power, of necessity will entail such losses. In this case, however, when distributed over the entire output, the loss is practically negligible.

Accurate Shaft Alignment *Made Easy*

How a number of simple tools are applied to the machine's coupling

By E. J. Jordan

SHAFTS that are to be coupled together, such as those of a turbine and generator or a pump and a motor, must be in alignment. This condition is obtained by moving the shaft bearings vertically and horizontally until the two halves of the coupling are true to each other, or until the axes of the two shafts coincide at the point where they are coupled.

The shafts must be loaded (not stripped) when they are aligned, so that they will have their total deflection. If the shafts are connected together by a rigid coupling, it is imperative that the face of each half be square to the axis of its shaft. This may be done by separating the coupling as far as the bearing will allow the shafts to be moved. Then, with a feeler, check the separation distance at some convenient point. Turn one-half of the coupling 90 deg. and make another check at the same position on the coupling half that is not moved. This check is continued by moving one-half of the coupling 90 deg. at a time. When this one has been checked, the other half may be tried. By revolving one-half of the coupling only at a time, the other can be used to provide a check point.

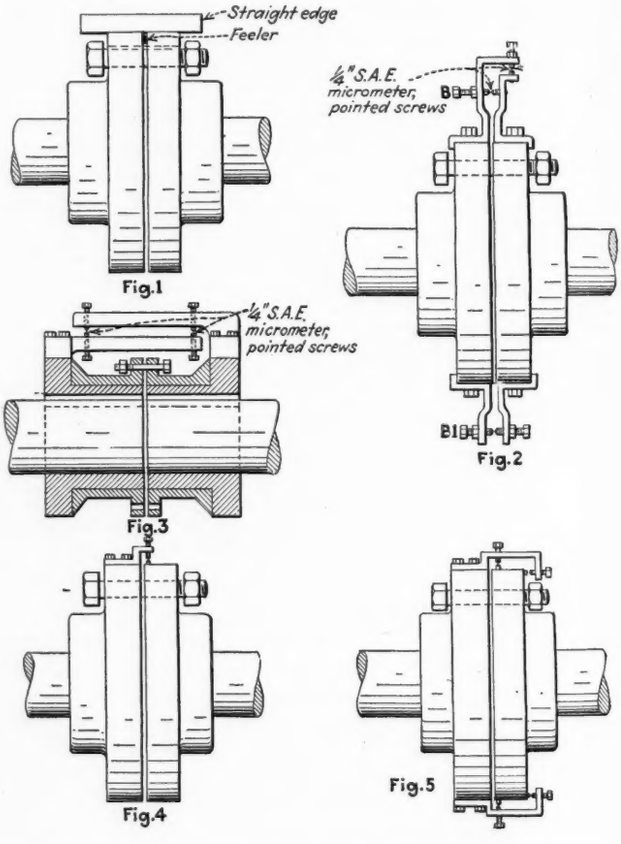
The usual method of aligning shafts is to connect the coupling with one or two bolts, free enough in the holes to prevent binding, and to allow end movement of the shafts. A mark is put on the rims of the coupling, the two shafts are revolved together, and a test made when the mark is on top, then on the bottom, then on each side. At each test a straight-edge is applied to the coupling rims and a feeler gage used to check their distance apart, as in Fig. 1.

The two valves of the coupling must be kept apart, as far as the shaft collars will allow, when gaging the distance between them. Generally, a turbine shaft is set to the machinery location plan and the generator shaft is the one adjusted. For motor-driven pumps the motor shaft is moved.

In the foregoing test, when the coupling halves gage the same distance apart at the marks when they are placed at the four quarters of a revolution, when the straight-edge test is also satisfactory, the shafts are in truth with each other at the coupling point. The coupling faces should now be exactly the same distance apart all the way round. If they are not, then one or both need truing up in the lathe or while revolving the shaft in its bearings.

A better way to align shafts, one that avoids the necessity of keeping the coupling spread apart and any error due to not doing this, is shown in Fig. 2. It has the advantage of placing the test points beyond the coupling rims, thereby increasing the accuracy of alignment. This method is not affected by the coupling rims not being concentric to the shafts' axis.

After the gages have been put in place and the micrometer points adjusted, the coupling is revolved 90 deg. at a time and tested in these positions. Feelers are used between the micrometer pointed screws. If the shaft is found out of line, it is adjusted to move the coupling one-half the amount of the error shown. By using the two measuring points B and $B1$, any end movement of the shafts while they are revolved may be neglected because it is necessary only that these points be the same distance apart, at any position in the revolution.



Figs. 1 to 5—Methods of aligning shaft couplings

Flexible couplings are frequently used, especially when there is likely to be change of alignment due to heat, wear or settling of the foundation. The flexible coupling allows of a certain amount of misalignment, but for best operation as much care should be taken when aligning this type as with rigid couplings. A modification of Fig. 2 can be used to align a shaft fitted with

flexible couplings. Fig. 3 indicates how the shafts of a large-turbine generator set were aligned, fitted with flexible couplings.

Fig. 4 shows how the shafts of turbines fitted with rigid couplings may be aligned when the coupling faces are known to be true. The alignment of the coupling faces is checked with feelers, as in Fig. 1, and the micrometer points are used instead of a straight-edge to check rim alignment. The arrangement, Fig. 5, is used when there is a doubt about the coupling faces being true and will serve to prove them.

An indicator set in a tripod, Fig. 6, may be used to align the shafts and is moved around the coupling rims by hand. This method avoids the necessity of revolving the shafts.

If, when the machine is in operation, one part of the coupled unit expands vertically more than the other, an allowance based on experience or estimate must be made and this checked by a hot test. This requires

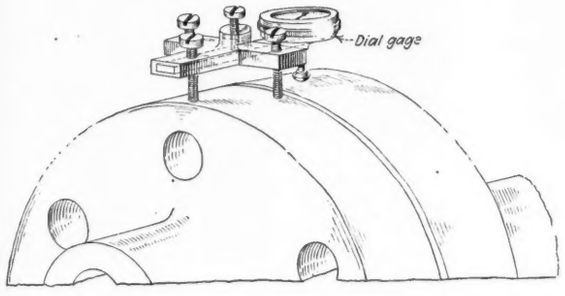


Fig. 6—Dial gage used to align shaft couplings

running the unit under full load until it has attained a working temperature. The machine is then shut down, the coupling bolts removed and the alignment check made. A resetting of the shims under the bearings may be necessary to bring the coupling in alignment.

Motor-driven pumps, when on a continuous bedplate, should be given a preliminary setting before the bedplate is grouted. This is to insure that the shims will be used under the motor feet.

Less Waste in Transmission

Heat insulation can be (and often is) too thin. It can also be too thick. No engineer wants to waste costly heat by inadequate thickness. Nor does he care to tie up excess first cost where it cannot earn its "board and keep." There is a way to figure the correct thickness for any set of conditions, but few engineers understand it.

An entirely new approach to this problem, sound technically and financially, but as absorbing as a detective story, will appear shortly in *Power*.

Elevators Automatically Controlled by Pliotron Tubes

By W. O. Lum

Industrial Control Engineering Department, General Electric Company

A NUMBER of methods have been developed for the automatic control of electric elevators. One of the latest uses pliotrons to level the car automatically with the landings. A pliotron composed of a filament, a grid and a plate, as indicated in Fig. 1, will oscillate if coils are arranged in the grid and the plate circuits in proximity to each other so that their fields couple and if the grid coil is suitably tuned with a capacitor across it. The plate coil, the grid coil and grid-coil capacitor are shown in the figure. The frequency at which the circuit oscillates is determined by the frequency of the tuned grid circuit. In standard General Electric elevator-leveling units this frequency is about 200 kilocycles.

Inasmuch as the coupling between the grid and plate coil is essential for oscillation, breaking this coupling will stop the oscillation. One of the car leveling units is shown in Fig. 3. *P* is the pliotron and the way the grid and plate coils are mounted back of the unit is indicated at *C*. How these coils are mounted is more clearly shown in Fig. 2. Inserting a metal vane in the space between the two coils prevents coupling of their fields and stops the oscillation of the circuits.

In an oscillating circuit of the kind described a considerable change in plate current occurs when the circuit goes in or out of oscillation. The plate current will be low when the circuit is oscillating and high when oscillation ceases. If an electromagnetic relay is connected in series with the plate circuit and the relay coil bypassed with a capacitor, as in Fig. 1, the difference in plate current through the relay coil will be further increased

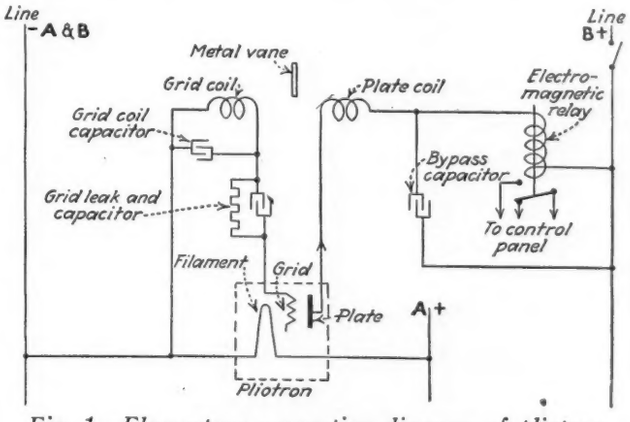


Fig. 1—Elementary connection diagram of pliotron control system

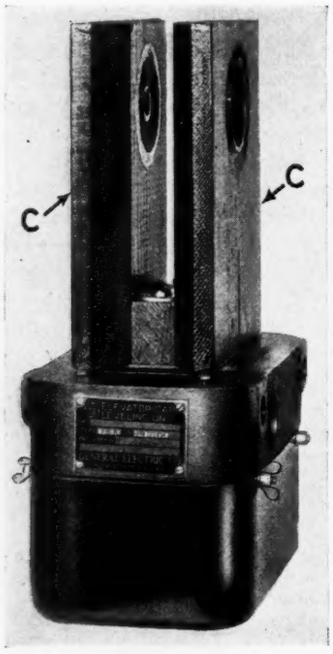
between the oscillating and non-oscillating states, because the highly inductive relay coil will not pass radio frequencies, but the capacitor in multiple with this coil will. In a non-oscillating condition the capacitor will pass on current and the relay will freely pass the direct current. The operation then will be, with the vane between the grid and plate coils the relay will be closed by the direct current; with the vane absent and the circuit free to oscillate, the relay will be open. The pliotron unit shown in Figs. 2 and 3 has approximately one-inch air space between the grid and plate coils, and $\frac{1}{16}$ in. radial movement of the edge of the vane between the coils is suffi-

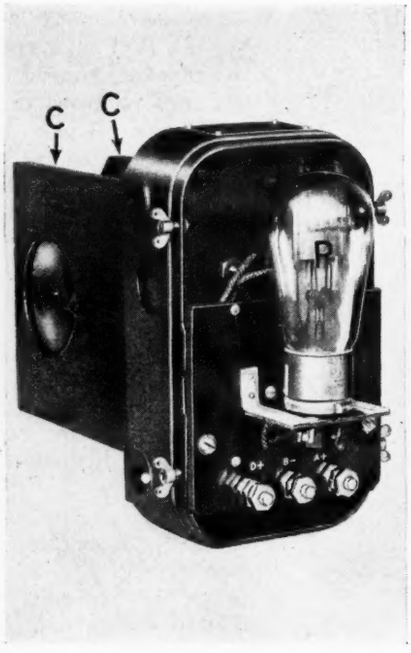
cient to pick up or drop out the relay. This pick-up and drop-out distance may be reduced if requirements demand.

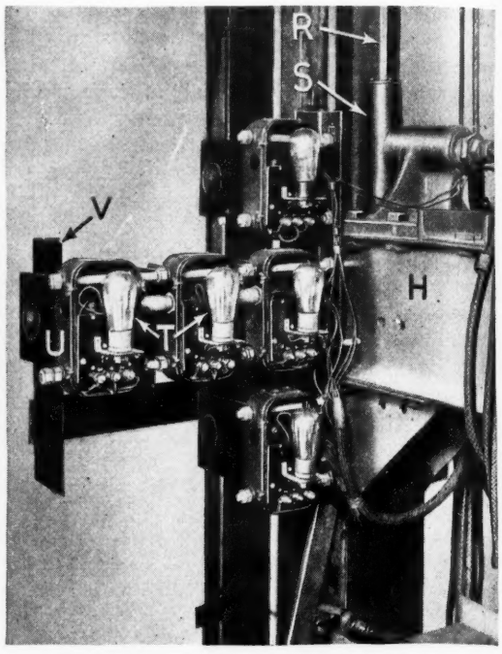
Fig. 4 shows a group of pliotron units mounted on the crosshead of an elevator car as used in a preregistering signal-control elevator system. On the photograph *R* is one of the car guide rails, *S* one of the car guide shoes, *H* the car crosshead, *T* pliotron tubes, *U* one of the pliotron units attached to the car crosshead and *V* is one of the metal vanes, clamped to the guide rails, which act on the pliotron circuit to level the car at the landings.

From the foregoing it is seen with this leveling system no mechanical connection of any kind is made in the hoistway with the control equipment. Slowing down and leveling the car at the floors is accomplished by metal vanes, properly located in the hoistway, passing through the space between the grid and the plate coils on the pliotron units, which in turn cause relays to function to carry out the slow-down and stopping operations.

The leveling operation is smooth. Transition from the first to subsequent approach speeds is imperceptible, and the final leveling-in to the floors is so gradual that the passengers are barely conscious of the change in speed until the car comes near to rest and a landing is made. The lever acts directly on the main traction motor and involves no auxiliary driving mechanism.







Figs. 2 to 4—Pliotron units used to level elevator cars at the landings

Fig. 2—The coils mounted in *C* are in the plate and grid circuits. Fig. 3—Pliotron unit with the cover removed. Fig. 4—Pliotron leveling units mounted on the car's crosshead. *H* is the crosshead; *R*, the guide rail; *S*, the guide shoes; *T*, pliotron tubes; *U*, one of the pliotron units attached to the car's crosshead; and *V*, is one of the metal vanes clamped to the guide rails, that acts on the pliotron's circuit to level the car at the landings.

Limiting Values for Acidity and Demulsibility of Turbine Oils

By H. L. Kauffman

Petroleum Consultant, Denver, Colo.

AN INQUIRY from a reader as to the limiting values for acidity and demulsibility on a steam-turbine oil, from the standpoint of how long it is "safe" to use such an oil without affecting lubrication detrimentally, has prompted this short discussion.

In the writer's experience, when a turbine oil shows a steam emulsion (A.S.T.M. method) of over 600, the turbine needs close watching thereafter for signs of emulsion difficulties. There is no definite relationship between the S.E. No. (A.S.T.M. method) and the U. S. Government demulsibility No. at 130 deg. F., but it is believed that an oil having an S. E. No. of 600 to 700 would have a demulsibility at 130 deg. F. of about 50 to 60.

So far as acidity is concerned, with a filtered turbine oil made from an asphalt-base crude, several times the writer has noted signs of corrosion when the oil showed around 1 per cent acidity (organic), calculated as oleic acid, determined in alcohol solution; but found no visible indications of corrosion when the same oils showed from 0.4 to 0.6 per cent acidity, also calculated as oleic acid. It would seem, therefore, that for this particular type of oil corrosive tendencies are more in evidence above about 0.5 per cent acid. And, as is commonly known, corrosion is more pronounced—even with an organic acidity—the greater the amount of moisture that is present. Unfortunately, the writer's experience with turbine oils made from crudes of different bases has not been extensive enough to make observations on what has taken place with an asphalt-base turbine oil necessarily applicable to those from other crudes.

COMMON DEFECTS

found in

Newly Installed Heating Systems

By Frank L. Gillmor

THERE appears to be a quite common lack of knowledge on the part of architects and heating and ventilating engineers as to what is considered good practice by boiler inspectors and insurance companies in the installation of heating systems.

It is not rare to find a new system containing from one to four defects that must be corrected before the installation is considered to be a first-class insurance risk. These defects are in some instances due to errors on the part of the heating contractor, but in a greater number of the cases are the result of improper design or inadequate specifications on the part of the architect or heating design engineers.

The average plant is designed for low-pressure operation. The boilers of themselves, if of steel construction, have a large factor of safety and, if of cast iron, usually give long and faithful service when operated under normal conditions. The service failures are in practically all cases directly traceable to improper design of the system or improper consideration to causes outside the system that may lead to failure. These conditions are more likely to be found in installations in buildings such as schools, churches, institutions, and in some cases in factories and similar buildings where there is a widespread floor area.

In cities of less than one hundred thousand population and in the outlying or residential sections of larger cities, electric service lines are usually run on poles along the streets and are subject to storm damage, particularly sleet storms, and also damage due to broken branches from trees. A fair estimate of power interruption from these causes is that an interruption of one hour's duration at least once in two years is to be expected.

Systems depending on a condensate tank and motor-driven pump to return the condensate to the boiler, and having no other means of supplying water automatically, are, as a general rule, not insurable. Each boiler should be provided with an automatic water feeder that will supply the makeup needed. A single feeder for a bank of two or more boilers is not adequate, as in seasons of low load, when some boilers are cut out, there is too much chance of the operator's not making the proper changeover with the feeder. If the system, however, is operated without reducing valves in the steam lines and provided the boilers are set below any piping that might act as a reservoir for condensate, then in some cases the system is safe with a bypass and check around the condensate tank. Any stop valve in the bypass line should be left open at all times. In this case the system automatically changes over to a gravity-return system in case of power failure.

When two or more boilers are connected in battery, numerous failures have occurred due to the operator's closing the steam stop valve on a boiler that was still generating steam and at the same time neglecting to close the valve in the boiler-feed line. Under this condition the steam will force the water out of the boiler, causing low water and damage to the tubes. This is such a frequent cause of trouble that the possibility of human failure of this kind should not be overlooked.

A check valve placed in the return line to each boiler, or the installation of what is known as the underwriters' loop, will prevent the water being forced from the boiler.

The underwriters' loop is a means of feeding a heating boiler near the water line, but having the water actually enter the boiler in the cooler space near the bottom. If properly installed, an equalizer pipe is connected either from the steam space of the boiler or from the steam pipe

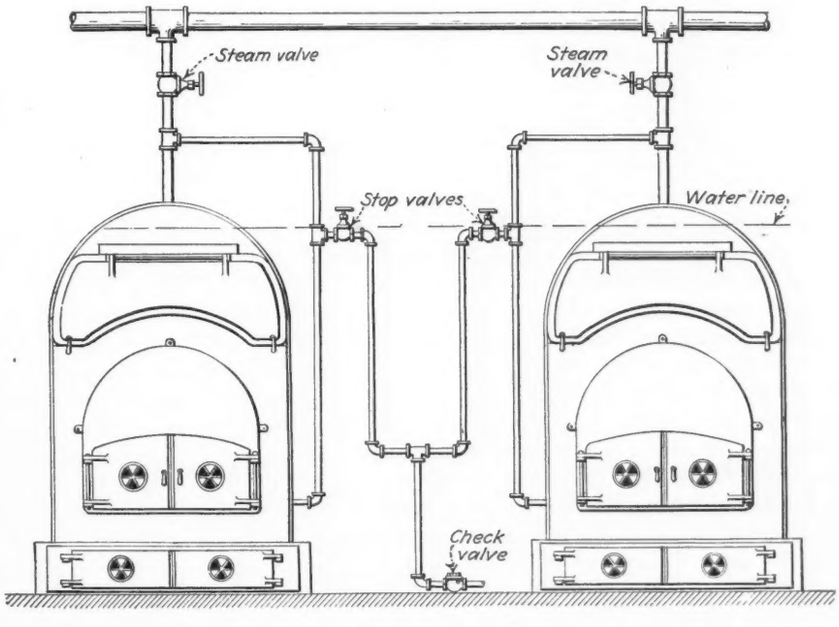


Fig. 1—Return piping for battery of two or more heating boilers

between the boiler and the steam stop valve down to the connection left by the manufacturer for connecting returns. The system return pipe then enters this equalizer near the water level, as shown in Fig. 1. The selection of the proper point to make this connection calls for rare good judgment. If connected at too high a point, say the level of the middle of the gage glass, the connecting pipe will not be flooded at all times, and water hammer will result. On the other hand, if it is connected too low, say several inches below the bottom of the gage glass, it will not be effective for the purpose intended.

The principal value of the underwriters' loop, aside from preventing the water being forced back out of the boiler suddenly, is that it also acts somewhat in the nature of an alarm in case of low water due to the water hammer developed. In many cases due to pecularities of the system return checks are advisable in addition to the underwriters' loop. In some cases there have been installed equalizer connections between the steam main and the return header and the underwriters' loop connected to this equalizer. This serves to balance the pressure in the return lines, but is not the proper installation to secure the safety of the boiler against low water.

Allow Ample Head Between Boiler Water Level and Radiators

A common fault in buildings of industrial type, where there is a large floor area, is the installation of a gravity return system with the boiler located at one end of the building and not allowing enough difference in level between the water line of the boiler and the bottom of the radiators. An example of this condition exists in a building 175 ft. long in which the boiler is in the cellar at the rear of the building. The cellar has a low ceiling, and from the water level of the boiler to the ceiling is a matter of only about 24 in. To aggravate conditions the return is a wet return for a distance of 50 ft. back from the boiler, then it rises to slightly above the water level and continues to the front of the building. This condition is shown in Fig. 2.

The boiler is a rapid steamer and will build up about 3 lb. pressure before the piping and radiators at other end of building are heated. Thus there is a large drop in pressure, with the result that the three pound on the boiler forces the returns to back up, filling the long pipe which is usually a dry return, and which then becomes a reservoir holding enough water to lower the water in the boiler to a dangerously low point. In this particular case several equalizer connections between the steam mains and return might relieve the situation somewhat, but the fundamental defect is lack of static head, which can be secured only by lowering the boiler into a pit about three feet deep. The return pipe near the front of the building should be rearranged so that it is either completely flooded at all times or will be practically empty. Another method sometimes used, though not recommended, is to install at the water level of the boiler a tank capable of standing boiler pressure, and connect return and equilizer lines to it. The purpose of this is to provide a large volume of water at the water line to counteract the effect of delayed returns.

I recently surveyed a job in an institution that is just being finished. The plant consists of two steel heating boilers for low-pressure operation and a high-pressure boiler for laundry and process use. The heating boilers are connected so that in case of power failure they cannot be fed. The high-pressure boiler, though located in a code state, has only one means of feeding and has five or six other code violations. The contractor installed the equipment according to the building specifications and claims he knew they were in violation, but carried out his contract. The state authorities are surely going to compel compliance with the state code as soon as the first inspector makes an authorized inspection. In the meantime the contractor has received his contract money, the architect has received his fee, and the owner will be faced with an additional expense of several hundred dollars that could have been prevented if the architect had known the code requirements or if he had written into the several contracts the phrase "and in accordance with all laws and ordinances." This line in the contract would have compelled the steamfitter to connect the high-pressure boiler according to the code.

I will summarize the several major items as follows: If steam stops are used, a check valve or loop is required. If a condensate pump is used, then positive automatic means of feeding is required. Avoid large, normally empty, pipe capacities at or near the water line of the boiler. This also applies to location of indirect heating coil stacks. Be sure to have enough static head between radiation and water level of the boiler so that water will not be held back in the returns by the difference in pressure between the boiler and the end radiation. In case of a high-pressure installation make sure of the code requirements and, if necessary, call in a state boiler inspector or insurance inspector on questions of doubt. In case of an installation in a none-code state install it according to the A.S.M.E. code or that of the nearest code state. Most owners insure their boiler plants not because they are afraid the boilers will blow up, but for the engineering inspection service that is rendered. It certainly does not leave a sweet taste in an architect's mouth to have some insurance inspector come in and criticize a new layout and, furthermore, point out the defects in such plain language that the non-technical owner can see where the errors have been made.

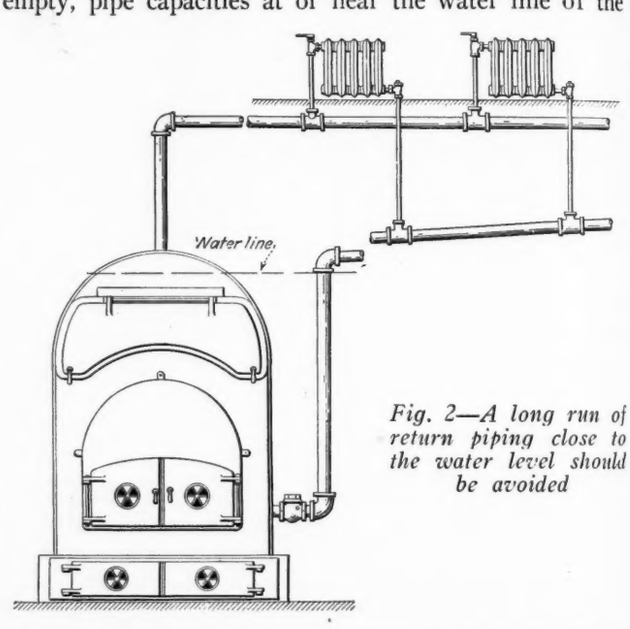


Fig. 2—A long run of return piping close to the water level should be avoided

This discussion has been written with full appreciation of the skill of the architect who designs a beautiful building, modern, and with utility features well taken care of, but he should stay within his own field and not attempt to design a boiler room about which he probably knows little.

Boiler Water Troubles Avoided by One of Three Methods

By Captain H. C. Dinger
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With the advent of high-pressure boilers and high ratings the question of the proper conditioning of feed water becomes of special importance. It will be noted from recent engineering literature that numerous plants have experienced difficulties because the feed water was contaminated. With low-pressure steam and low ratings the effects of contaminated water are not as serious, but the cost of cleaning boilers and of tube renewals is, in either case, a considerable item.

Chemical researches have now developed means of treating feed water that make possible the avoidance of both corrosion and scale in boiler tubes. At comparatively slight outlay for apparatus and reagents the need for cleaning can be reduced to perhaps an annual or semi-annual examination and inspection.

The three principal methods in vogue for producing this happy result are:

1. Distill makeup water. Deaërate condensate either by special means in the condenser or by deaërating apparatus. Maintain a sealed system as far as the admission of air from the atmosphere is concerned.

Periodical tests should be made of the condition of boiler water and condensate for air, condenser leakage and alkalinity. Addition of reagents may be necessary to control alkalinity. Consistent stoppage of all air, condenser leakage and other sources of feed contamination must be maintained.

Concentration of boiler water should be controlled by properly regulated blowdown, ridding the boiler of any accumulations of sludge or solid matter.

This is an approach to the ideal and is practiced by some large central stations where conditions are favorable. As a result, these plants have no scale accumulations, blowdown is used hardly at all, and boilers do not have to be cleaned on the water side more than once a year, when little or no dirt is found. On some vessels, both naval and marine, similar conditions sometimes obtain.

The ideal is to keep out definitely air and impurities from the feed water. If there is nothing but pure water in the system, there will be no corrosion, no scale, no dirt, and no blowdown required. Although air-contaminated, distilled water will produce some corrosion; air-free distilled water will not when placed in a closed system.

2. Pretreat makeup feed by means of lime-soda, zeolite and other external processes. Filtering should be used with such methods as necessary.

Periodic tests should be made for alkalinity, air and condenser leakage. After-treatment should be used to control alkalinity. Properly controlled blowdown and deaërating apparatus should be used.

These methods, under favorable conditions, may produce good results. Where no deaëration or after-treatment is applied, somewhat less favorable results may be expected. This is probably cheaper than distilling, depending upon the character of the makeup water. Where water is highly charged with a variety of salts of a non-uniform character, distilling is probably more satisfactory and less expensive, particularly for super-pressure boilers.

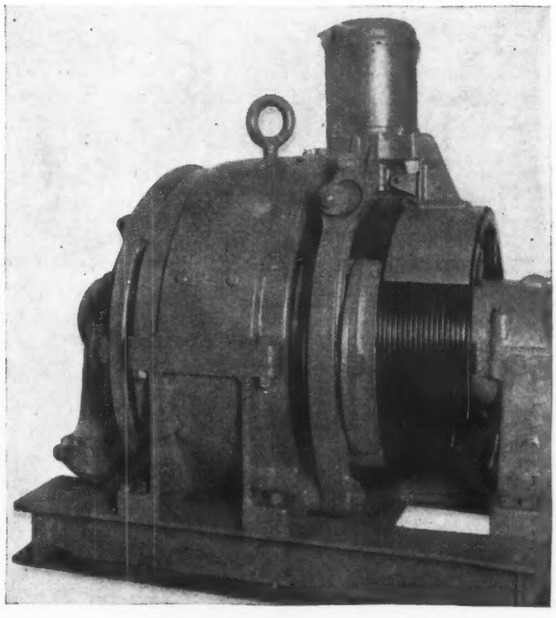
Conditions also may be such that there is no very compelling reason for after-treatment; but a periodic test and after-treatment gives additional assurance that proper conditions are uniformly maintained and that any deficiency in the pretreatment is covered by after-treatment.

3. Feed water may be conditioned by reagents added in the boiler or in the feed as it goes to the boiler. Usual reagents are lime (suitable only for low-pressure work) soda ash, caustic soda, trisodium phosphate, sodium aluminate, and mixtures containing some of these with small amounts of ingredients such as tannins, starch and colloidal substances. Anti-foaming or anti-priming ingredients such as alum and castor oil are sometimes used.

By the selection of the proper chemicals for the nature of the water, provided the water is fairly soft and does not contain a high concentration of salts, satisfactory results can often be secured. However, if the water varies to any considerable extent and careful control is not maintained, the results may be anything but happy.

In many localities the water supply is of such a nature that any slightly improper condition can be corrected by the addition of the correct reagents and the expense of distilling or of special external treatment may be saved.

However, the use of boiler reagents should be carefully controlled to suit the particular conditions. Proper practice having been once determined, it can be carried on by the regular operating force and a periodic check made by a chemical consultant.



The 110-hp. gearless traction elevator motor, which pigeon-holes automobiles in the sky-scraper Kent Garage, New York City, is one of the most powerful of its kind ever built. Loads of 10,000 lb. are hoisted at 450 ft. per min.; about triple the speed of the ordinary freight elevator. This Westinghouse unit is rated at 110 hp., 290 volts, 93 r.p.m. and is roped 2 to 1 for high-speed service. The control equipment insures floor landings within $\frac{1}{4}$ in. from exact level.

Table I—Tabulation of Bids for Condenser Unit

Letter of Bidder	A	B	B*	B	B*	B	B*	C	D*	D	E*	E	F*
Price	$88,400	$76,000	$75,480	$79,200	$78,940	$82,500	$82,375	$87,900	$81,450	$87,000	$79,855	$80,605	$84,365
Price less ferrules	88,150	75,850	75,330	79,050	78,790	82,350	82,225	$87,900	$81,200	$86,725	$79,855	$80,605	$84,365
Time for shipment (weeks)	18	16	16	16	16	16	16	16	16	16	18	18	16
Time for erection (weeks)	9	5	5	5	5	5	5	6	4½	4½	5	5	7
Weight of cond. with tubes (lb.)	192,500	142,000	142,000	146,000	146,000	150,000	150,000	197,000	133,200	161,600	179,000	179,000	180,000
Weight of circ. pump (lb.)	9,000	12,000	12,000	12,000	12,000	12,000	12,000	6,700	11,725	11,725	12,000	12,000	222,500
Weight of cond. pump (lb.)	2,200	1,900	1,900	1,900	1,900	1,900	1,900	4,000	2,000	2,000	2,800	2,800	5,400
Sq.ft. of tube surface	22,000	22,000	22,000	24,000	24,000	26,000	26,000	22,000	22,000	24,000	22,000	22,000	22,000
Circ. water (G.P.M.) 1 pump	16,500	18,000	16,800	17,500	16,800	16,500	16,800	17,500	15,500	16,500	15,500	17,500	16,100
Circ. water (G.P.M.) 2 pumps	26,000	27,000	25,000	26,000	25,000	25,500	25,000	26,500	24,000	26,300	24,000	27,000	24,000
Abs. back press. in hg. oper. both circ. pumps with 55 deg. F. water and condensing steam as follows: 220,000 lb. per hp	1.28	1.24	1.31	1.24	1.27	1.24	1.23	1.27	1.36	1.23	1.36	1.25	1.344
170,000 lb. per hp	1.00	1.00	1.04	1.00	1.02	1.00	1.01	1.00	1.07	1.00	1.07	1.00	1.063
125,000 lb. per hp	0.86	0.83	0.86	0.83	0.85	0.83	0.84	0.84	0.89	0.84	0.88	0.80	0.873
90,000 lb. per hp	0.73	0.72	0.74	0.72	0.73	0.72	0.72	0.73	0.76	0.73	0.75	0.72	0.752
Abs. back press in hg. oper. both circ. pumps with 55 deg. F. water and condensing steam as follows but oper. one circ. pump: 170,000 lb. per hp.	1.35	1.26	1.32	1.27	1.30	1.31	1.29	1.30	1.40	1.32	1.42	1.30	1.378
125,000 lb. per hp.	1.05	1.00	1.04	1.01	1.03	1.03	1.02	1.03	1.10	1.05	1.11	1.03	1.075
90,000 lb. per hp.	0.85	0.83	0.85	0.83	0.84	0.87	0.84	0.84	0.9	0.86	0.89	0.84	0.884
Loss of head in feet when rated quantity of circulating water is passing condenser: Condenser	9	11.79	10.24	9.52	8.90	7.87	7.56	9.8	9.35	9.35	8.4	10.2	8.5
Refigured	11	11.20	9.05	9.40	8.67	7.75	7.59	11.33	9.48	9.64	9.48	11.76	9.48
Piping	1	0.85	0.66	0.75	0.66	0.60	0.66	2.2	2.5	2.75	3.0	3.0	1.5
Average allowance	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82
Siphon loss	3	3	3	3	3	3	3	3	3	3	3	3	3
Unchanged	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Level difference	2	2	2	2	2	2	2	2	2	2	2	2	2
Unchanged	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total head	15	17.64	15.9	15.27	14.56	13.47	13.22	17	16.85	17.1	16.4	18.2	15
New total head	17.92	18.02	15.87	16.22	15.49	14.57	14.41	18.15	16.30	16.46	16.3	18.58	16.3
Hp. and efficiency of circ. pumps at full rating when suction lift is 8 ft.: Hp.	60	70.7	58.8	59.1	53.9	51.6	49.5	71.2	60	67	59.2	74	53.5
Speed r.p.m.	345	400	400	400	400	400	400	380	435	435	350	350	277
Per cent efficiency	82	85	85	84.5	85	84	84	80	85	85	84	84	85
Hp. speed, head and efficiency of condensate pump: Hp.	84.7	82	82	82	82	82	82	82.2	96.5	96.5	84	84	87.5
Speed, r.p.m.	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,760	1,750	1,750	1,750	1,750	1,150
Head, ft.	375	380	380	380	380	380	380	380	381	381	376	376	375
Per cent efficiency	67	70	70	70	70	70	70	70	60	60	68	68	65
Steam required for each air removal equipment, lb. per hour: 1st stage	210	145	145	145	145	145	145	225	117	117	300	300	186
2nd stage	315	350	350	350	350	350	350	225	350	350	400	400	336
Friction—Int. and aft. cond. (ft.)	10	2.5	2.5	2.5	2.5	2.5	2.5	5	4.25	4.25	6	6	2
Condensate depression, deg. F.: 220,000 lb. per hour	2.4	0	0	0	0	0	0	0.5	0	0	1	1	1
170,000 lb. per hour	3.2	0	0	0	0	0	0	1	0	0	1	1	2
125,000 lb. per hour	5.0	0	0	0	0	0	0	1.5	0	0	1	1	2
90,000 lb. per hour	5.0	0	0	0	0	0	0	2	0	0	1	1	2
Tube characteristics: O.D., inches	1	1	1	1	1	1	1	1	1	1	1	1	1
Active lengths (ft.)	20	20	20	20	20	20	20	20	20	20	20	20	20
Number	4,200	4,210	4,210	4,600	4,600	4,975	4,975	4,200	4,200	4,580	4,202	4,202	4,200
Number of passes	2	2	2	2	2	2	2	2	2	2	2	2	2
Pressure drop—steam in. to air off	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.05	0.09	0.09	0.05	0.05	0.2
Velocity of water in tubes	6.2	6.27	5.8	5.65	5.44	5.12	5.025	6.3	5.7	5.75	5.7	6.41	5.7
Refigured hp. of circ. pumps	71.6	72.0	58.5	62.8	57.2	55.8	54.0	78.3	58.0	64.5	59.1	75.5	58.1
Total hp. of pumps	227.9	226.0	199.0	207.6	196.4	193.6	190.0	241.3	212.5	225.5	202.2	235.0	203.7
Total air ejector steam, lb. per hour	525	495	495	495	495	495	495	450	467	467	700	700	522
(*m*) Initial bid	$88,400	$76,000	$75,480	$79,200	$78,940	$82,500	$82,375	$87,900	$81,450	$87,000	$79,855	$80,605	$84,365
(*n*) Total hp. × $388.64	$88,550	$87,850	$77,760	$80,750	$76,280	$75,000	$73,950	$939,900	$82,500	$87,550	$78,500	$91,250	$78,950
(*o*) Total air ejector steam × $13.10	$6,878	$6,485	$6,485	$6,485	$6,485	$6,485	$6,485	$5,895	$6,118	$6,118	$9,170	$9,170	$6,838
(*p*) Deg. F. condensate depression × $742	$2,374	.....	.....	.....	.....	.....	.....	$742	.....	.....	$742	$742	$1,484
(*q*) Increase or decrease in steam consumption above or below 29 in. vacuum	.....	.....	+$5,870	.....	+$2,935	.....	+$1,468	.....	+$10,273	.....	+$10,273	.....	+$9,248
(*r*) Total evaluation (M + N + O + P + Q)	$186,202	$170,335	$165,595	$166,435	$164,640	$163,985	$164,278	$188,437	$180,341	$180,668	$178,540	$181,767	$180,885
Comparative sequence, all bids	30	17	9	12	7	5	6	31	24	25	21	27	26
Total evaluation less original bid (R—M)	$97,802	$94,335	$90,115	$87,235	$85,700	$81,485	$81,903	$100,537	$98,891	$93,668	$98,685	$101,162	$96,520
Compression of bids based on original specifications	$104,717	$88,850	$84,010	$84,950	$83,155	$82,500	$82,793	$106,952	$98,856	$99,183	$97,055	$100,282	$99,400
Sequence of bids based on original specifications	12	6	4	5	3	1 Accepted bid	2	13	8	9	7	11	10

*Meets orig. spec. except vac. requirements.

Buying a Condenser

Basis of capitalization employed by the consulting engineers in selecting fourth unit for Morrell Street Station, Detroit

By C. S. Lumley
Smith, Hinchman & Grylls, Detroit

TO THE present installed capacity of three 20,000-kw. units in Morrell Street Station, owned and operated by the City of Detroit, is being added a fourth unit of the same rating, making a total installed capacity of 80,000 kw. The new turbine is a machine of the same design as the ones previously purchased. In determining the proportioning of the condenser for the No. 4 unit, developments in condenser design and construction made since the initial installation, were reviewed and analyzed in comparison with the performance of the present units.

Inasmuch as this installation comes under the heading of municipal work, it was necessary to prepare a specification in such form that all tenders would cover equipment as nearly alike as possible. The design of condensers, however, is largely affected by patents, basic designs, standards, use of existing patterns, etc., and as a result bids could not be on a sufficiently common basis that the bid price alone would be a suitable criterion. It is sometimes found that the condenser with the highest first cost has sufficient advantage over all others to place it economically in first position.

Alternate Proposals Permitted

In view of the restrictive latitude allowed the commission in awarding contracts, the specifications established the number of passes and certain minimum limits of surface and pump capacity, but provisions were made whereby proposals could be considered on an alternate specification in which these limits were waived and which the commission had the option of accepting. The specification also included a basis of capitalization applicable to all tenders, giving values for steam, auxiliary power, plant capacity and improvement in steam consumption for increase in vacuum, as indicated in Table I.

Naturally, the alternate specification allowed a great deal of freedom in design and resulted in a large number of heterogeneous proposals carrying extreme divergence in price and operating characteristics. It, however, reserved to the commission the option of awarding the contract on the basis of either the original or alternate specification, and provided means for taking advantage of any unusual features of design that might be offered by the various manufacturers.

A total of 33 proposals were received, and these were divided into two classes, one class consisting of 13 proposals meeting the requirements of the original specification, and the other class consisting of 20 proposals that were based on the alternate specification for which provision had been made.

All bids were then capitalized in accordance with the basis for capitalization as given in the specifications. The results of the capitalization, together with the tabulation of bids, were compiled in a table large enough to accommodate the 33 proposals.

In view of the great diversity of bids received in the second class and the equipment offered by the low capitalized bids in this class being of such a nature that they did not conform readily to the plant layout, it was decided to eliminate this class entirely and award the contract on the basis of the original specification. Owing to space limitations they are therefore omitted from the accompanying table, and only the 13 proposals meeting the original specification are reproduced.

Details of Condenser Selected

Thus the condenser negotiation ended with the purchase of a condenser of the straight down-flow type of horizontal two-pass design with 26,000 sq.ft. of surface made up of 4,975 tubes, 20 ft. long and 1 in. in diameter. The steam-jet air-removal equipment consists of two individual two-stage elements, each mounted on a combined surface type inter-and-after condenser, and is designed to operate over the entire range of steam pressure without the use of reduction valves. Circulating water is supplied by two 12,750-g.p.m. pumps, each driven by a two-speed, shunt-wound, direct-current motor. Condensate is handled by two 600-g.p.m. pumps, each driven by an open squirrel-cage motor designed for full voltage starting.

The general arrangement and design of the equipment purchased is such that the uniformity in arrangement and appearance of the station layout has been preserved, and it is believed that, on account of the great latitude allowed the bidders, the most economical condenser obtainable for the installation has been purchased under these conditions.

TABLE II—BASIS OF CAPITALIZATION

Value of steam per 1,000 lb.	$0.0.25
Value of auxiliary power per kw.-hr.	$0.0075
Value per kilowatt of plant capacity required for operation of condenser auxiliaries	$50.00
Rate of capitalization for differences in annual cost, per cent	10.5
Average load, kw.	17,000
Hours operation per year at average load	5,500
Improvement in steam consumption for 0.1 in. increase in vacuum, lb. per hour	864

Expansion Loops of FITTINGS AND STRAIGHT PIPE

More Flexible Than Pipe Bends

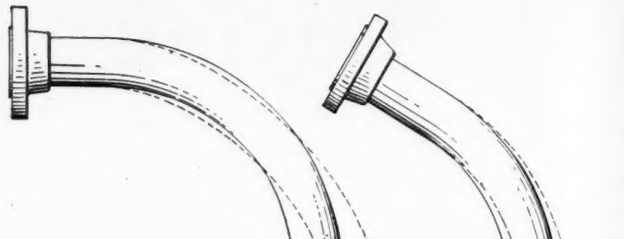


Fig. 1—Types of distortion found in pipe bends

By J. A. Freiday and F. A. Ericson

Thomas E. Murray, Inc.

THE trend toward higher steam temperature, together with the increased size of steam piping, due to increased steam loads, has introduced new problems in piping design. Compensating for expansion in pipe lines without putting too much stress on the various pieces of equipment to which the steam lines are connected is one of these problems. Several years ago trouble was experienced on certain installations that we were connected with. This led to an investigation of all of the methods then in use and resulted in the elimination of common forms of pipe bends used for taking care of expansion.

An investigation of the trouble experienced with the standard type of bend leads to the conclusion that it was impossible to figure the stress that would be produced in a pipe line where it was used, because of the distortion created in the pipe during fabrication. The bending of the pipe while hot precluded the possibility of the bends being made accurately to dimensions, as some distortion occurred during cooling with the result that the conditions existing on an actual installation were entirely different from the calculated conditions.

Our investigation showed there was a tendency in a good many cases for the pipe bend to straighten out producing thrusts in directions that had not been contemplated. This evidently was due to improper annealing of the pipe that had been strained during the bending operation. Fig. 1 illustrates this condition.

The straightening-out process was found to be gradual. In the first case noted, the bend was the final piece of pipe in a turbine lead and was connected to the throttle valve. Following the usual practice of the turbine manufacturer, the joint between the throttle valve and the pipe was broken, after the line had been heated up, in order to check the relation of the pipe to the throttle valve. The pipe was found to be in line and the specified clearance between flanges was met. After the turbine had been in operation for over a month, it was noticed that the throttle valve was out of line, and, when the joint between the throttle valve and the pipe was broken, the pipe was found to cause a thrust against the valve flange. The bend was removed, the dimensions checked with the original dimensions, and it was found that there had been an increase in the center to face dimension. The bend was then sent to the fabricating plant and cut off to the proper dimensions. It was then reinstalled and checked as before. However, after the turbine had been in operation for some time, the same trouble developed again; and the bend was once more taken out and cut off. This was repeated the third time before satisfactory results were obtained. Upon making a check of other installations the same conditions were found to exist, although they were not as noticeable as in the first case.

Another difficulty with standard type bends is the space required for installation, particularly when a large size pipe is used. Bends, made of large size pipe, are also hard to handle, both in shipment and installation.

At the end of our investigation, we concluded that any piping system, to give satisfaction, must be designed to meet the following conditions:

1. *The cross section of the pipe should not be distorted during fabrication.*
2. *No strains should be introduced during fabrication.*
3. *There should be no tendency to straighten out after installation.*
4. *Dimensions should be accurately met.*
5. *Shipment and installation should be simplified.*
6. *The maximum amount of deflection in the minimum space should be provided.*

The design developed meets all of the above conditions. It consists of a system of loops made up of straight pipe and ells. The fact that only straight pipe is used simplifies fabrication, avoids the possibility of distortion of the cross section and makes the handling and installation much easier.

Fig. 5 shows a typical installation beginning at the superheater outlet and ending with the connection to the turbine. It will be noted that only straight pipe is used.

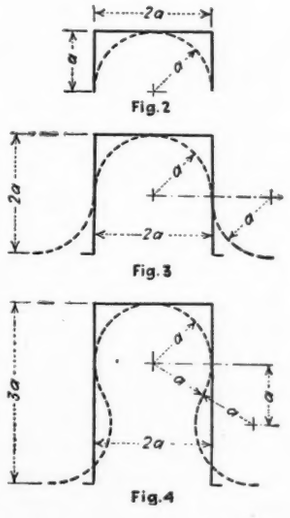
The turbine lead, as shown, is designed to prevent any thrust from the piping being transmitted to the turbine. The vertical connection from the main header is supported at the bottom with long rod hangers, which take all of the load, but allow the bottom of this connection to move horizontally. At the bottom of the vertical connection a rectangular loop is provided. The opposite sides of this loop are of equal length thereby equalizing expansion; the connection leading from this loop to the turbine is supported by a spring hanger. This arrangement compensates for expansion of the turbine without creating an excessive thrust.

Comparing the pipe bend made up of straight pipe and fittings and the expansion loop bend, it is found that the former gives more flexibility in a given space than the latter. In making the comparison, the formulas for deflection of straight bends as found in part 1 of "Modern Frame Structures," by Johnson, Bryan and Turneaure and the formula for deflection of circular bends from an article by J. G. Stewart, published in *Power*, May 10, 1921, are used.

Calling the radius of bend a, stress S, deflection D, diameter of pipe d, force P, E the modulus of elasticity and I the moment of inertia, the equation for deflection in the plain U bend, Fig. 2, is $D = \pi \frac{a^2 S}{Ed}$. But for the straight line bend using practically the same space $D = \frac{16}{3} \frac{a^2 S}{Ed}$, and $P = 2 \frac{SI}{ad}$, which is 70 per cent greater. For the expansion bend, Fig. 3, $D = 3\pi \frac{a^2 S}{Ed}$, while for a straight line bend of the same dimensions $D = \frac{40}{3} \frac{a^2 S}{Ed}$ and $P = \frac{SI}{ad}$, which is 41.5 per cent greater. For the double expansion bend, Fig. 4, $D = 18.48 \frac{a^2 S}{Ed}$, while for a straight line bend of the same dimensions $D = 24 \frac{a^2 S}{Ed}$ and $P = \frac{2}{3} \frac{SI}{ad}$, which is 30 per cent greater.

These calculations are based on the assumption that the ends are free to move, which necessitates locating anchors some distance from the bends.

In making use of ells for the right-angle turns, the deflection will be slightly reduced; but, allowing for this, it can easily be seen that a bend of this type is more flexible than is the circular bend. The fiber stress in the ells will tend to increase on account of the short radius, but as the body of the fittings is considerably heavier than the body of the pipe it can easily be proven that there is no possibility of rupture at these points. To check calculations, bends were made up with a large radius compared to size of pipe. Others were made up from straight pipe and fittings. The result agreed closely with calculations.



Figs. 2, 3 and 4—Comparison of expansion loops made of fittings and straight pipe, and loops made of pipe bends

This method of compensating for expansion has been criticized for two reasons: it requires more joints than the standard bend; it causes a greater pressure drop than the standard bend.

More joints are required with our method; but, as the size of pipe used increases, the difference in the number of joints used with our method as compared with the standard method decreases. The installation of

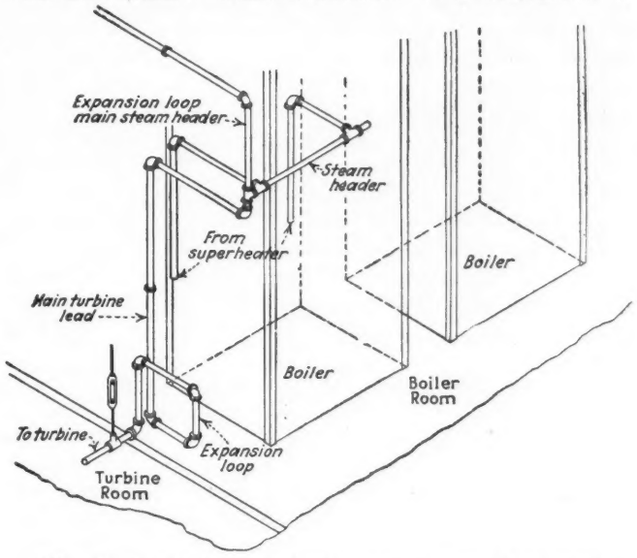


Fig. 5—Typical layout of main steam piping with expansion taken up by loops made of fittings and straight pipe

a few additional joints, if properly made, should not be a source of worry; and the results obtained certainly justify their installation.

Regarding the question of increased pressure drop where fittings are used, we have found by observation of several different installations that the actual pressure drop in lines having several right-angle ells is only a small percentage of the calculated pressure drop. This indicates that the formulas used for determining the pressure drop in right-angle ells are not correct. It may be that the same conditions apply to pressure drop in right-angle bends in steam lines as have been found with air ducts, where right-angle bends result in less pressure drop than long sweeps. Our experience has been that loops made up as described have no greater pressure drop than the standard expansion bend.

Because the top of the racks at the intake to a hydraulic power plant are clean, is no indication that everything is all right all the way down. In some cases, particularly on streams where there is a lot of refuse carried down from industrial plants, the intake may fill up from the bottom. Although a careful raking of the racks will show them to be clean down as far as the rake will go, only the upper section of the racks may be reached. As the intake fills up from the bottom, the available rack area is reduced and the water velocity through the racks increased. The loss of head due to this cause has amounted to one foot or more. With a plant operating normally under a 20-ft. head, one foot loss through the racks is a 5 per cent loss of the power for the water available.

Right Out of the Plant

Gaging Thousandths of an Inch Without a Micrometer

TURBINE bearings, engine cylinders and other cylinder bores may be accurately measured without a micrometer. When any large bearing is rebabbitted and bored, you will probably want to measure it and to know the exact clearance it will have on the shaft without actually having to set the bearing up in place. When your engine or pump cylinder is somewhat worn, you want to know the exact amount of wear and whether it is out of round and how much. With the proper size micrometer or pin gage this is easy to do, but many an operator does not have access to the different sizes of micrometers he would like to use, especially the larger and more expensive ones. I have often been in this predicament and have for some years used a little trick, simple, but accurate enough for all practical purposes.

For bearing measurement a piece of heavy iron wire (No. 6 will do) is cut and filed down to a length to correspond to the exact diameter of the shaft. This can be checked with ordinary calipers. Then by standing this wire inside the bearing to be measured and making note of the shortest allowable swing of the free upper end of the wire, the amount of this swing referred

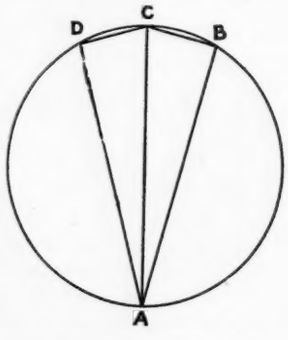


Fig. 1—Side AC of the triangle equal the diameter of shaft plus clearance

to the chart prepared for the purpose will indicate the bearing clearance. The curve reproduced here (see Fig. 2) is used in determining clearance of bearings on an 8-in. turbine shaft. You will note that a swing of one inch referred to the curve would indicate a bearing diameter of 8.015 in., or 0.015 in. more than the shaft diameter. Here we have assumed that the length of the wire is exactly 8 in. Whether it actually is or not is of no importance; if the length of the wire is the same as the diameter of the shaft, then the bearing clearance will be indicated with all the accuracy desired.

Suppose the actual diameter of the shaft is 8.050 in., and the wire, being calipered to match, is 8.050 in., and standing in the bearing its shortest free swing is one inch. Then the curve will give you 0.015 in. more than the base length just the same, and although the actual diameter of the bearing is 8.065 in., the actual clearance is 0.015 in. just as indicated by the curve. Regardless of the actual diameter of the shaft, so long as it is approximately 8 in., and the wire length is the same as the shaft diameter, then the difference between this length and the diameter of the circle to be measured is accurately indicated by this curve.

The chart and curve reproduced here give correct clearances for any bearing of approximately 8 in. diameter. For any other diameter a different chart and curve must be prepared. After laying out the desired range to be covered, a few points may be calculated, after

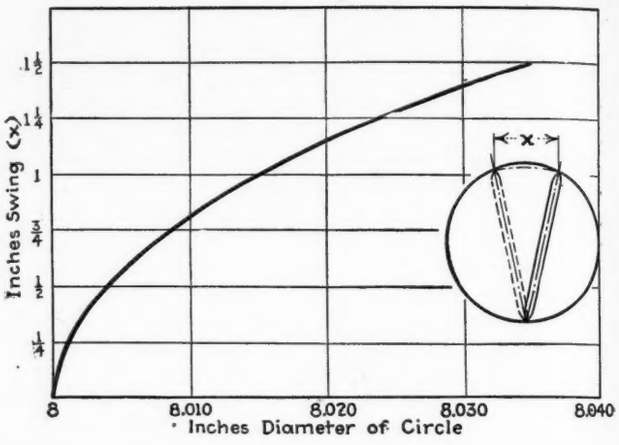


Fig. 2—Curve shows bearing clearance indicated by swing of pin gage

which they may be plotted and the complete curve drawn in. In the circle, Fig. 1, with diameter AC, the angle ABC will always be a right angle regardless of the proportionate lengths of AB and BC. Likewise, the angle ADC will always be a right angle. In the triangle ABC, the length of the side $AC = \sqrt{(AB)^2 + (BC)^2}$. The practical application of this figure to our specific problem is, of course, to let AB equal the length of our measuring rod and let BC equal half the distance struck by swinging the measuring rod within the circle of the bearing to be measured. Then the distance AC will be the true diameter of the circle we are measuring.

The true mathematician will probably nail me on this one, but the error is within allowable limits and will not work to the detriment of this application, and by means of it any operator may measure and record clearance or wear in important bearings with all the accuracy he needs.

R. E. THOMPSON.

Springfield, Mo.

What Is a Foot?

INDIRECTLY through the columns of the *Valve World* we learn of Mr. Low's Foreword (July 24, 1928), criticizing our own criticism of the Power Test Code of the A.S.M.E. which defines the yard and the pound in terms of the meter and kilogram respectively.

Our contention—and we still adhere to it—is that in this country the yard and the pound should not be defined in terms of the meter and the kilogram.

The Metric Act of Congress of 1866, which the article cites, did not define the customary units in terms of the metric, but instead it defined certain metric units in terms of the customary.

In 1866 the metric units needed defining, and Con-

gress defined them in terms of the customary units in use. Anybody can read this act himself and find:

The tables in the schedule hereto annexed shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system; and the tables may lawfully be used for computing, determining and expressing in customary weights and measures the weights and measures of the metric system.

In the tables in the Act, the customary units included are the mile, foot, inch, yard, gallon, quart, gill, pound, acre, etc. And all these common-law units existed long before the Act of 1866.

The Power Test Code of the A.S.M.E. reverses the procedure of the Act of 1866, which Act is still in force.

W. E. Bullock, Secretary,
American Institute of Weights and Measures.
New York City.

Changing a 2,200-Volt Generator for 220-Volt Operation

A REQUEST to change the voltage of a 105-kw. three-phase 60-cycle 30-pole 240-r.p.m. rotating-field engine-type generator from 2,200 volts to 220, appeared at first to be a simple problem. Further checking revealed that the machine was of the one coil per slot variety, with a concentric chain winding, coil ends in two ranges and groups connected in series on each side of the winding.

The preliminary data gave a series-star connection for 2,200 volts. Then, for 220 volts a 10-parallel star connection would give the desired results. With 30 poles and a 2-layer winding there are eight possible connections, series and 2, 3, 5, 6, 10, 15 and 30 parallels. However, the connecting diagram for the original 2,200-volt winding, Fig. 1, showed the machine to have 180 slots, 90 coils in 45 groups of two coils in series, one coil per slot.

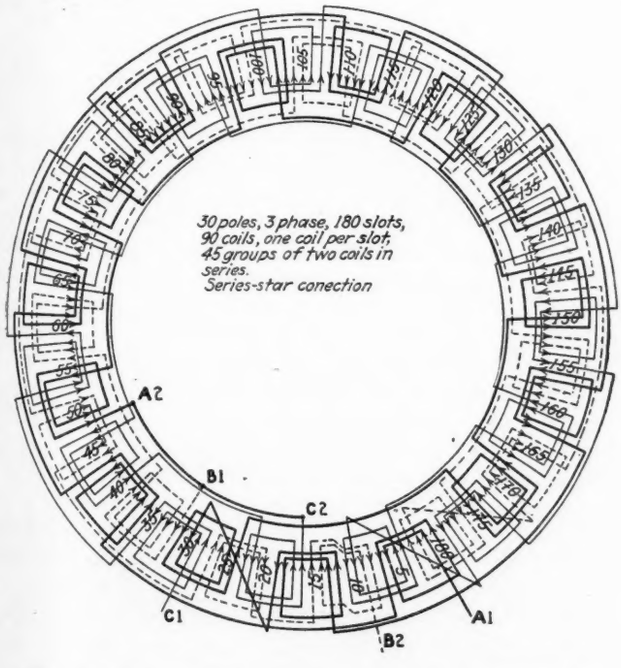


Fig. 1—Generator winding connected series-star for 2,200-volt operation

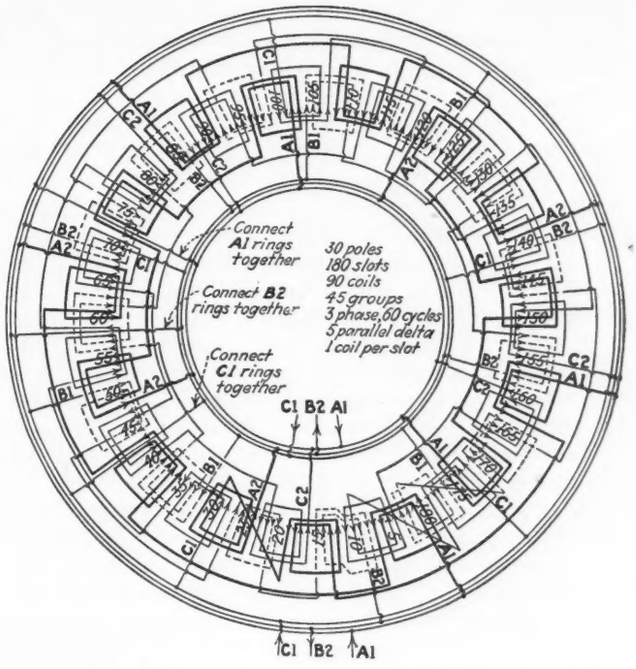


Fig. 2—Winding, Fig. 1, grouped five-parallel-delta for 220-volt operation

It is impossible to use a 10-parallel connection with 45 groups or 15 groups per phase. Further checking indicated that a series-delta connection would give a line voltage of 2,200 ÷ 1.732 = 1,266 volts; then, to obtain 220 volts a 5-parallel connection would be the nearest, as 1,266 ÷ 5 = 253 volts. As this was satisfactory, a 5-parallel delta connection diagram was made up as in Fig. 2.

The new winding required 3 connection rings on each side of the machine. One lead on some of the coil groups came out on the opposite sides of the core from where the connection had to be made. These connections were made by passing the lead under the core iron as shown by the three diagonal connections from slot 19 to 30, 179 to 10 and 171 to 2 in the figures. Additional cross connections were used to connect the A_1, the B_2 and C_1 rings together as shown. The resulting five-parallel delta connection with 3 groups in series solved the problem and saved an expensive rewind.

The one coil per slot windings are not as flexible for reconnecting for voltage or phase changes as the modern two-layer windings and problems involving windings of the old type should be carefully checked.

Wilkinsburg, Pa. A. C. Roe.

Heating by Electricity

IN THE March 5 number, F. V. Larkin gives an analysis used at Lehigh University to show the comparison of heating a house by coal and by electricity and asks if the analysis is unsound. It is not unsound, but it seems to me it does not tell the whole story.

One kilowatt-hour contains	3,412 B.t.u.
Assume 10 per cent loss in distribution	341
Leaves for heating	3,071 B.t.u.

If this were compared with the B.t.u. burned in a

small plant near the house, Professor Larkin is correct in his comparison, but suppose it was generated in a modern steam plant and a kilowatt-hour would be generated at the switchboard for one pound of coal, or 13,500 B.t.u. This would be over 22 per cent of the heat units which the house would receive instead of the 12 per cent shown by Professor Larkin.

Further, consider the B.t.u. in the coal purchased by the central station are bought at the rate of $4 per ton of coal and the same B.t.u. in coal bought by the individual householder cost $16 to $18 a ton, and a comparison does not look so bad.

Electric heat can be used at a greater efficiency by putting it where wanted at the time desired, and unless the weather is very cold it is conceivable that heating by electricity may be fairly comparable in cost.

One of the New England power companies made some actual experiments a few years ago by installing electric coils in individual water radiators. As I remember coal was $8 a ton and electricity figured at 3c. a kw.-hr., and on this basis the cost balanced when the outside temperature was 60 deg. F. Above this temperature electricity was the cheaper, below this temperature coal was the cheaper.

Today, coal for household use would cost at least twice as much as when these tests were made, and current from the central station could be delivered for less money. Furthermore, people have more money than heretofore and are willing to pay extra for comfort and convenience, as is evidenced by the many electrical cooking and heating devices in actual use.

By building houses with proper insulation, storm windows and doors and equipping radiators with thermostats so arranged as to shut off when the temperature reached a comfortable point, it would be possible to heat by electricity today in certain climates. I formerly lived in a city in northern Minnesota, and for one winter there were 53 days in succession that the thermometer did not go above zero and yet we were comfortable and used only one-half the coal that we had to burn the next year in a Pennsylvania town in a similar sized house. The first house was built for cold weather and had storm windows and doors; the second house was not built so well and did not have storm windows and doors.

The central station has saved money for many industries on their power bills by inducing them to modernize their power drives and purchase power, and I believe they could likewise save many industries money in the heating of their plants by persuading them to modernize their heating systems and heat by electricity.

New York City. J. B. CRANE.

Waste-Water Pumps Have Flexible Control

AT THE State Hospital, Rockland, N. Y., the State engineers were faced with the problem of disposing of waste water from a sewage disposal plant. This water had to be pumped to a creek where it could run away. To do this a sump was built for the waste water, and at this sump three pumps were installed, each driven by a 75-hp. 2,200-volt 3-phase motor.

Under normal conditions, one pump will take care of all the water, but occasions arise when two and even three of the pumps will be required. Three float switches are used and are located in the sump to close at three different water levels. These switches allow starting automatically one, two or three motors as the water rises in the sump.

To make it possible to control one, two or three of the motors from any one of the float switches, three-way transfer switches were installed in each of the motor control circuits. The float switch and transfer-switch circuits are shown in the figure. With No. 1 transfer switch closed on point 1, No. 2 closed on point 2 and No. 3 closed on point No. 3, the three motors will be started in succession as the water rises in the sump.

Assume No. 1 float switch to close at the lowest level. When the water rises in the sump to where No. 1 float switch closes, a circuit is made from the potential transformer, through No. 1 float switch to No. 1 contact on each transfer switch, through No. 1 transfer switch to

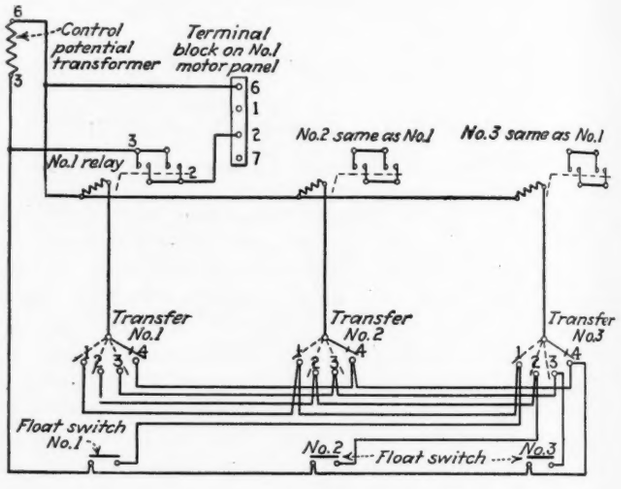


Diagram of float-switch and transfer-switch connections to the motor controllers

No. 1 relay coil and to the transformer. Energizing No. 1 relay coil causes it to close its contacts and complete the control circuit for No. 1 motor, which goes into operation. If this pump has not sufficient capacity to keep the water from rising, when it reaches a level where No. 2 float switch closes, No. 2 motor will be put into operation. Should the water continue to rise, when it reaches the level for which No. 3 float switch is set, this switch will close and start No. 3 pump.

Any other combination of starting the pumps may be had by closing the transfer switch to give the desired arrangement. For example, if the three transfer switches are closed to their No. 1 position all three pumps will be started and stopped by No. 1 float switch. Point No. 4 on the transfer switches allows starting the motors when the float switches are open. Closing point No. 4 on No. 1 switch will start No. 1 motor, when No. 1 float switch is open. This control allows the operator to choose the pump he wishes to have in operation and, by careful selection, he will operate the different pumps for approximately the same number of hours per year.

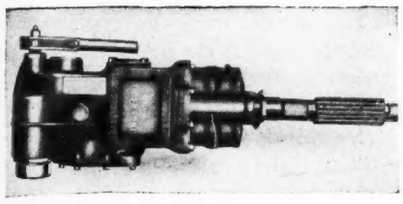
As a matter of interest, the water for this hospital comes from a reservoir some distance from the hospital. In order that the superintendent may know at all times the water level in the reservoir, Selsyn water-level indicators have been installed. E. W. PILGRIM,

Industrial Engineering Department,

Schenectady, N. Y. General Electric Company.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Air drill for use in close quarters

Improved Close-Quarter Air Drill

THE new air-driven drill illustrated, designated Size 90, has been designed especially for use in close quarters and to give 20 per cent more horsepower and 10 per cent higher stalling power than the former units of its type.

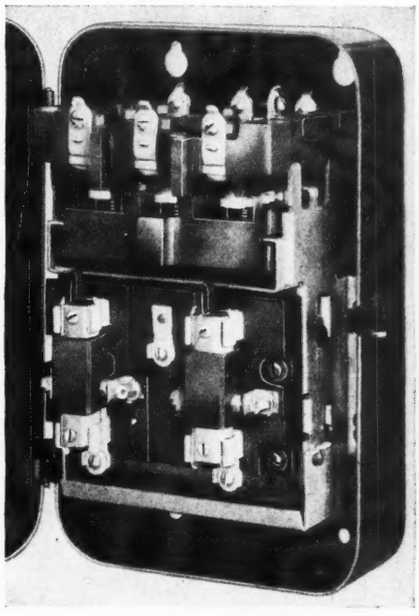
Minimum thickness of the machine has been obtained by making it flat, it being practically the same thickness from the spindle to the cylinders. Smoother operation has been secured by arranging the pistons to act at right angles to and in a plane with the spindle. A counterbalanced crank, herringbone gear for the final drive and anti-friction bearings of the ball or roller type are used.

Three different spindles can be furnished, the standard spindle having a No. 4 Morse taper socket. A threaded spindle $1\frac{1}{16}$ in. in diameter, 12 threads per inch, to take square socket chucks, can also be furnished. The third spindle obtainable is a "Use-Em-Up" spindle, which has a No. 4 taper. The drill is put out by the Ingersoll-Rand Company, 11 Broadway, New York City.

Across-the-Line Starter With Multi-Break Contacts

THE Condit Electrical Manufacturing Corporation, Boston, Mass., announces a new line of across-the-line starters for squirrel-cage induction motors in sizes up to 20 hp., 550 and 440 volts; 15 hp., 220 volts; and $7\frac{1}{2}$ hp., 110 volts. In this starter the contacts are arranged so that each leg of the circuit is broken at four places. This number of breaks in series prevents arcing at the contacts. The purpose of the design is to prevent an arc forming when the contacts open, whereas with many other designs the arc is allowed to form when the contacts open, after which it is extinguished by a blowout magnet.

In the figure the contacts are shown at the top of the illustration. The



Starter breaks each leg of the circuit in four places

contacts are arranged in horizontal groups. The moving contacts have a vertical motion. As there is practically no arcing when the circuit is interrupted, arc chutes and blowout coils are not required, consequently the design is simple.

One of these starters was tested on a 20-hp. 440-volt squirrel-cage induction motor. This starter opened and closed the locked rotor current of the motor 437 times at ten-second intervals, when the heating of the motor made it necessary to discontinue the test. During this time there was practically no sparking at the contacts on the starter.

The starter is furnished for remote control with thermal relays for overload protection and arranged for under-voltage protection.

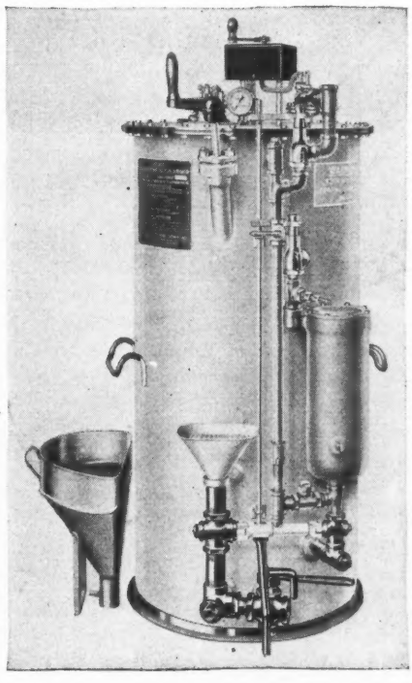
Medium-Pressure Acetylene Generator

THE type MP-101 medium-pressure acetylene generator illustrated, has been developed especially to meet the demand for a stationary or portable generator that can be used in connection with either medium-pressure or low-pressure welding and cutting blowpipes. Minimum pressure fluctuation during operation is one of the important features of the new unit.

Heavy gage material has been used in the construction of the generator and, where strength is required of the fittings, steel castings have been used. The carbide valve is rotated by means of a spring clock motor which, in turn, is governed by diaphragm type motor feed control. The motor is enclosed in a dust-tight housing and is wound with permanently attached ratchet lever.

Pressure adjustment is easily made by means of a thumbscrew on the motor feed control. Fluctuation during normal operation is said to be less than 1 lb. per sq.in. and even under

Type MP-101 medium-pressure acetylene generator



severe load the carbide feed is regulated to limit after-generation to a maximum increase of 1 lb. The close regulation permits operation of the generator close to the limit of 15 lb. pressure without loss of gas through the relief valve when the blowpipes are turned off.

Time required for shutting down the generator, flushing and refilling with carbide and water is about 15 minutes. Relief valves are opened by raising an interference rod to vent the air-gas mixture after refilling so that it is unnecessary to vent the hose or pipe lines connected to the generator. The feed valve cone can be raised to seal the hopper when the generator is being moved. This valve is also automatically raised, closing the hopper, every time the carbide filling door is opened. The hydraulic back-pressure valve and filter are contained in a seamless drawn shell with a flange cover and outlet casting, bronze-welded to the shell.

The carbide capacity of the generator is 30 lb. and the quarter-size ($\frac{1}{4}$x$\frac{1}{2}$-in.) carbide is used. The overall dimensions are: height, 60 in., and width, 34 in. The weight of the generator empty is 305 lb. With a full charge of carbide and water, the weight is 623 lb. The generator is a recent development of the Oxweld Acetylene Company, 30 East 42nd Street, New York City.

High-Voltage Circuit Breaker Operates on New Principle

NO OIL, low maintenance, ease of inspection and the ability to interrupt heavy alternating-current power in air quicker than a comparable oil circuit breaker, are features of the new Deion circuit breaker, developed by the Westinghouse Electric Company, East Pittsburgh, Pa. Based on deionization of the arc stream, the method constitutes a fundamental advance in high interrupting-capacity circuit breakers.

As in an ordinary type of air breaker, a long vicious arc forms at the arcing terminals as the contacts open. A magnetic field, produced by the line current flowing through a few series turns, blows the arc upward into the deionizing chamber. The deionizing chamber *D* consists of a number of thin metal plates spaced $\frac{1}{16}$ in. apart and located at the top of the breaker, Fig. 1. The long arc, on entering the deionizing chamber, is broken into a multiplicity of short arcs, each $\frac{1}{16}$ in. long, which are caused by a magnetizing field to rotate and are extinguished. A deionizing chamber is shown in Fig. 2 and one of the deionizing plates at *A*.

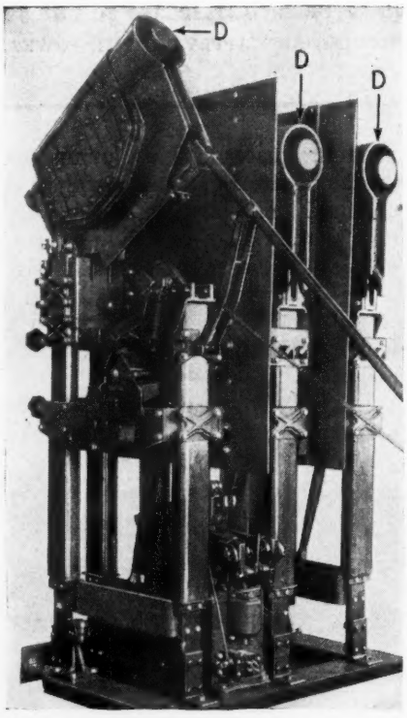


Fig. 1—One of the deionizing chambers is raised to expose the breaker contacts

If the short arc stood still 1/120 part of a second the structure would weld together. It is necessary therefore for the arc to move fast. In one-half cycle (1/120 sec.) each arc spins around its own annular path about fifteen times, while the arc is being drained of ions. This movement of the arc is caused by a radial magnetic field acting between sections of the deionizing chamber.

The quick extinction of the arc in the Deion breaker clears a fault with minimum disturbance to the system. Commercial oil breakers need four to eight cycles (60-cycle power) to open the circuit as compared to the one-half to one cycle required by the Deion unit when opening large short-circuit currents.

During operation the following sequence takes place in the Deion circuit breaker:

1. The arc, resulting from opening the circuit, is drawn in air.
2. The arc is blown into the deionizing chamber at the top of the breaker, by a magnetic field.
3. The original arc is broken up into many short arcs $\frac{1}{16}$ in. long.
4. Each short arc is magnetically rotated during extinction at a speed greater than the velocity of sound.
5. Complete deionization occurs, as the line current passes through zero, and the circuit is broken.

Three-phase and isolated-phase breakers, operating on this principle, have been successfully tested on the 12,000-volt system of the Commonwealth Edison Company and in the laboratories of the Westinghouse company. One of the breakers withstood over 250 short-circuit, interrupting currents ranging from 5,000 to 15,000 amperes, without any maintenance. Extensive tests have also been made on 2,300-, 4,500- and 7,500-volt lines.

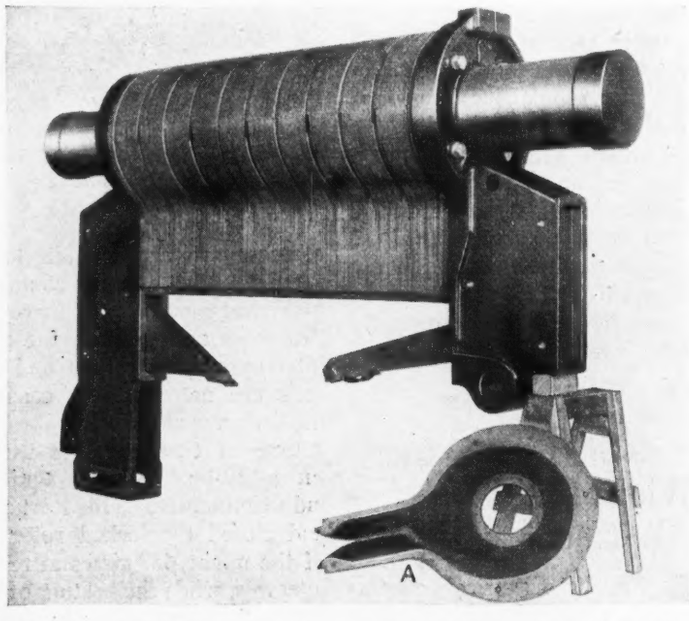
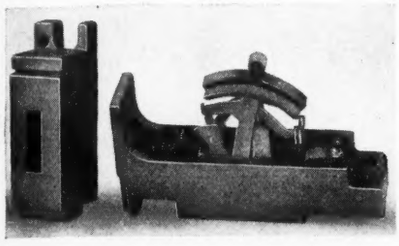


Fig. 2—Deionizing chamber consists of a number of metal plates, such as shown at A

Small Circuit Breaker Has Large Interrupting Capacity

THE little 15-ampere circuit breaker shown in the figure, is a product of the Westinghouse Electric & Manufacturing Company. It is only slightly larger than the household flush-switch, but it has repeatedly broken a dead short circuit on 110-volt mains, fed by many thousand kilowatts capacity. The actual current broken was 3,500 amperes at line voltage.

The continuous carrying capacity of this breaker is 15 amperes. In effect the device is a renewable fuse, the interrupting ability of which pro-



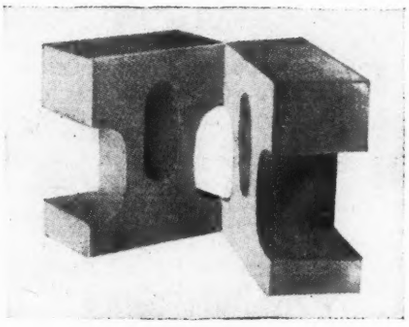
Circuit breaker on the right, cover on the left

vides for safe use on any system of its rated voltage, regardless of connected power. The breaker is full automatic and cannot be held closed against overload. It has an inverse time-element trip, permanent calibration and contact resistance, and is particularly intended for automatic panelboard duty.

Built-up Furnace Wall Air Cooled Below Fusion Temperatures

AIR cooling has been given an impetus by the development of a new furnace wall of built-up refractory blocks having three times as much heat-dissipating as heat-absorbing surface. Forced or induced circulation of air through tortuous passages within the blocks makes it possible to maintain uniform face temperatures approximately 600 deg. below that of the furnace.

Two types of wall have been developed, one designed for relining work, principally in stoker installations, where it is unnecessary to molest the present wall, and the other a complete wall for any type of boiler furnace. For lining, a built-up wall of air-cooled blocks, 9 or 13½ in. thick, is supported by anchors running through the common brick supporting wall. The complete installation is a sectionally supported wall, 18 or 22½ in. thick, consisting in one case of 13½ in. of air-cooled block supported on steel framing, backed by 4½ in. of rock wool insulation and a steel casing, and in the other case

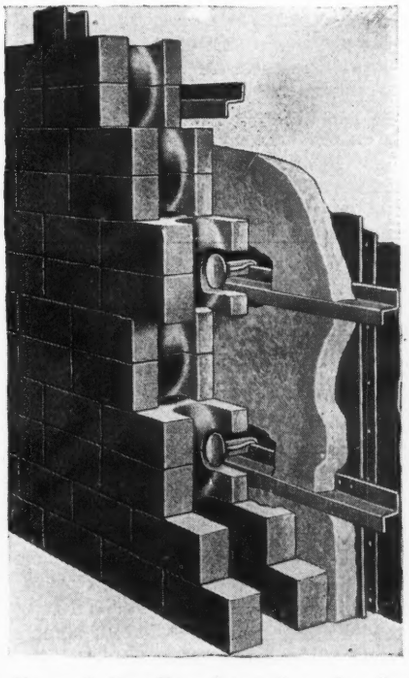


Typical block made in halves, with hollow core and stream line center section

the same block construction backed by 8 in. of common or face brick.

The wall framing consists of vertical I-beams spaced on 4 to 5 ft. centers, with horizontal Z-bars on 24-in. centers, to which the blocks in alternate horizontal rows are anchored. The floating rows are supported by the anchored blocks, leaving each section of two blocks free to expand as a unit, or to be removed without disturbing adjacent sections.

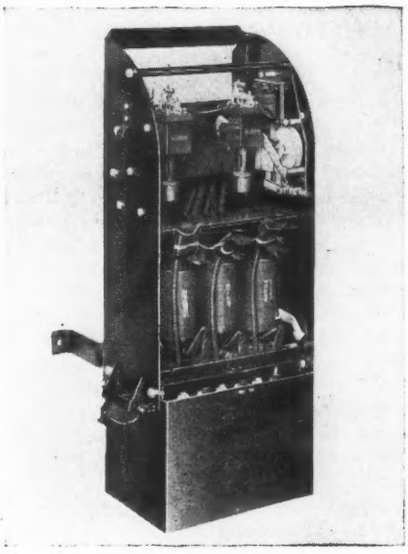
Blocks 12x12x13½ in. deep, are used. They are made in two halves



Air cooled wall construction showing air ducts, framing and flexible anchorage

with 4½ in. of fire face, 6½ in. air space and 2½ in. of rear supporting leg. This design of block gives approximately 3 sq.ft. of heat dissipating area to 1 sq.ft. of absorbing area. For each square foot of furnace wall there is approximately 36 sq.in. of free air lane surrounded by hot refractory, making possible heat dissipation at a rate of 4,500 to 6,000 B.t.u. per hour.

The Furnace Economy Company, 407 S. Dearborn St., Chicago, is the designer of the new wall.



Compensator with cover removed

Starting Compensator for Use in Gaseous Atmospheres

A HAND-STARTING compensator designed especially for use in places where there are explosive gases or gasoline fumes, is announced by the General Electric Company, Schenectady, N. Y. The new starter which is designated as CR-1034-N-52 is a modification of standard equipment so designed as to eliminate exposed arcing, thereby preventing any possibility of an explosion in a dust-laden or gaseous atmosphere.

The starting switch is oil-immersed and in place of the usual push-button tripping device a standard time-relay undervoltage attachment and dashpot relays are used with Cooper-Hewitt mercury tubes substituted for the usual contact types of the dashpot relay. The compensator is available for use with motors operating on 25 to 60 cycles two- or three-phase circuits in sizes of 15-hp. and less for 110 volts and 125 hp. and less for 220, 440 and 550 volts.

FROM AMONG THE READERS

Conducted
By
L. H. Morrison

Resetting Valves to Change from Condensing to Non-Condensing Operation.—*What changes should be made in the valve setting of a Corliss engine if a change is made from running condensing to non-condensing?* A. C. H.

When running non-condensing the exhaust will be at a higher pressure, and for smooth running of the engine the necessary cushioning on the exhaust can be obtained by less compression, obtained by closing the exhaust valves later in the stroke.

On a single-eccentric engine, set the eccentric back on the shaft so that only the necessary compression of exhaust is obtained, and see that the exhaust-valve rods are short enough to obtain release before the end of the expansion stroke. Setting the eccentric backward will delay admission and the steam-valve rods will need to be shortened so the valves will have less lap and proper lead.

With the wristplate hooked in gear, place the engine first on one center and then on the other, and adjust the valve rods to suitable lengths for obtaining the proper lead and release. With a double-eccentric engine, setting of the steam eccentric and steam valve gear needs to be no different than when running condensing, but for less compression of the exhaust the exhaust eccentric and exhaust-valve gear would require the same attention as the valve gear of a single-eccentric engine.

Deposits on Diesel Exhaust Valves.—*In our plant the exhaust valves of our Diesel engine burn at frequent intervals. On inspection we find a white deposit, or scale, on the valve face, which by flaking off allows the hot gases to blow by, burning the valve face. What is this deposit?* L.M.R.

This deposit is probably salt. In some Mid-continental pools the oil carries a considerable percentage of salt. This will not burn in the cylinder and will settle on the valve.

The remedy is to analyze the oil you are using and if salt is found, insist that the refiner supply oil that is free from salt.

Conversion of Pump into Air Compressor.—*What changes should be made in a single direct-acting steam pump to convert it into an air compressor?* R.W.W.

Ordinarily the water cylinders of pumps are provided with a liberal percentage of clearance volume as it is advantageous to their operation and adds convenience in their design and construction. For compressing air efficiently there should be a minimum percentage of cylinder clearance and conversion of a steam pump into an efficient air compressor would at least require replacement of the water cylinder by a properly designed air cylinder.

Boiler Water Walls.—*How are boiler furnace water walls piped up to the feed water system?* F.C.H.

Usually the feed water enters one of the boiler drums and the feed line to the water walls is led out of this drum and the return, or steam line, from the walls discharges into the boiler steam drum. There are modifications of this plan; for example, at the Trenton channel plant the water walls have their own feed water system, drums and safety valves, and are connected only at the steam outlet end to the main boiler.

Measuring Furnace Air Weight.—*Does the usual air-flow meter actually measure the weight of air entering the boiler furnace?* P.P.R.

One might say that the boiler air flow meter did not measure air at all. However, the readings are proportional to the flue-gas flow velocity, and consequently the volume, but not necessarily the weight.

The meter measures the draft, differential between a point just ahead of the damper and a second point somewhere in the boiler gas passage. As the gas velocity is proportional to the square root of the pressure difference, the meter indications are proportional to the gas velocity. If the gas volume at any given draft is known, the meter readings will then indicate the gas volume at all draft readings. Assuming the flue gas temperature to be constant, these volume readings could be interpreted in terms of pounds of gas, and with a constant ratio of air to coal, the readings can be said to indicate pounds of air entering the furnace.

The Holly System of Return.—*Is the Holly system for returning condensation to the boiler no longer considered good practice? Our plant engineer wants to install one but our consulting engineer says it is not modern and recommends a system of condensation pumps.* E.A.G.

While the Holly system is old it has so many good features that in some of the largest of the modern plants it is being used. As to whether it is the apparatus to meet your needs is of course impossible to say without knowing all the details of the plant.

Packing Valve Stems.—*Is it better to pack valve stems with packing rings or with a continuous piece of packing?* R.F.C.

The separate coils are preferable, with the joints staggered. When the valve is small, say ½ inch or less, a flexible packing such as a graphited wicking usually is easier to install and is equally satisfactory.

Why a Jet Type Condenser Does Not Flood.—*It has been stated that if the head of a barometric condenser is not high enough above the tail race it will pull up water and flood the engine. Why does this not happen with a jet condenser where the water is removed by a pump, which might be run too slow?* G.L.R.

In a barometric condenser the water entering the head from the intake line drops down the tail pipe and in mixing with the steam, condenses the latter. This creates a vacuum in the condenser head. If the condenser head is not at least 34 ft. above the water surface of the tail race, the atmospheric pressure will force water back up the tail pipe and so flood the condenser. At any time the height of water level in the tail pipe is at a point equivalent to the difference between the absolute pressure in the condenser head and the atmospheric absolute pressure.

Turning now to the jet condenser, if the supply of water is ample the vacuum in the condenser will be maintained as long as the pump keeps the chamber free of water and air. If the pump slows down the water will raise in the condenser throat and submerge the nozzle rows through which the water jets into the condenser head. The steam would not be condensed as it would then depend only upon the water surface for cooling. The vacuum will be destroyed and the relief valve would open. Ordinarily flooding of the engine can not occur, but even so, it is advisable to have a vacuum breaker.

Pumping Dense Brine With a Centrifugal Pump.—*We have a 4-in. centrifugal pump now used for water pumping, but which we wish to use for brine pumping. Will the curve showing the water pumped against discharge head be the same in case of brine pumping.* A.D.C.

If the heads are expressed in feet elevation the characteristic curve will be the same regardless of the density of the liquid. If, however, the elevations are in pounds per square inch the curve cannot be applied to brine, but a new one can be constructed, making the elevation readings proportional to the specific gravities of the water and brine.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

IN A plant containing an alternating-current engine-generator set having a shaft governor, which operates in parallel with a transmission line, how can I substantially alter the load the engine carries? G.R.P.

SINCE the engine is equipped with a shaft governor it is only necessary to vary the tension of the governor spring to secure load regulation. The point of cutoff is regulated by the governor. Compressing the spring sets the point of cutoff farther down the stroke, thereby letting more steam into the cylinder before expansion occurs. Releasing the spring decreases the amount of steam admitted to the cylinder, therefore the engine does less work. This is the simplest and safest means of regulating the load on this type of governor. CECIL E. SCOTT.

Iowa Railway and Light Corp.
Cedar Rapids, Ia.

WITH this type of engine driving an a.c. generator it can be generally said that the load cannot be substantially altered while running in parallel with another source of power, unless its governor is provided with a device whereby the spring tension may be altered while in operation.

I assume from the question that there is no such provision, also that the generator capacity is small compared to that of the transmission line.

If, however the engine generator is comparatively large as regards the rest of the system, the governors of the other prime movers might be adjusted while running, in which case the engine governor would automatically function to make the engine take the remainder of the system load.

In this way the engine load might be varied an amount equal to the capacity of the other units operating with it.

Circumstances might be such that boiler pressure or back pressure could be raised or lowered and the load controlled to a limited extent, but this at best would be hardly practical and not very economical.

Varying excitation of the generator field will not as many believe, have any influence on the mechanical load of the engine, as in direct current work, but will result simply in the relative amount of idle current taken by generator and line.

A shaft governed engine for parallel operation of a.c. generators is not a very satisfactory proposition unless fitted with a means whereby the cutoff may be adjusted while running.

A. M. LEADER.
Fitchburg, Mass.

MY EXPERIENCE has been that very little, if any, control of load can be secured by manipulation of rheostats.

I was operating a plant consisting of three engine-driven sets all equipped with shaft governors, running in parallel with another station a mile away. We had the governors set for operating under normal capacity of the generators when the throttle valves were wide open. When desiring to take additional load on any or all of the units, a request usually coming from the other station, we simply slackened up the locknuts on the steam-admission valve spindles and gave more steam admission to the valve. Consequently the generators took a greater share of the load.

No trouble was experienced by the engines racing while under load, but before the set was taken off the line the valves were put back where they had been previously.

C. A. CUTTING.
Elec. and Water Works Supt.
Humboldt, Sask.

THE load may be substantially altered on an A.C. engine-generator set running in parallel with a transmission line by equipping the shaft governor with a speed-changing motor, to give maximum frequency at full load. The throttle may be operated to reduce the load or the steam pressure may be increased or decreased at the boiler to give desired results.

If it is impossible to change the steam pressure at the boiler, a reducing valve, preferably hydraulically operated, may be inserted in the engine line. The reason for the hydraulic valve is that certain weights may be used for certain loads.

As a summary, I would suggest that a speed changer is the most refined method but expensive on certain kinds of shaft governors, especially if the unit is small. A reducing valve of sufficient size to control a 500-kw. unit is costly.

New York City. C. W. PETERS.

THE amount of load the engine will take, other conditions being equal, will depend upon the position of the governor weight arm, and this is determined by two factors, one being the engine speed, and the other the spring tension.

The speed is already determined by the line frequency, therefore the only practical way of changing the load is by changing the governor's spring tension. This is accomplished by means of a small reversing motor geared to a nut that adjusts the pull on the spring. The motor is then connected with a double-throw switch through the means of slip rings on the engine shaft in the usual way.

This arrangement is not only desirable for changing the load but also for bringing the generator into synchronism with the line. LEON ROUNDY.

North Billerica, Mass.

IF THE engine under consideration is equipped with a governor it should be set so that it will not begin to cut off steam until the generator speed is well above synchronism. The load of the machine can then be controlled by a hand valve in the steam line. The more steam admitted, the greater will be the load assumed by the generator.

D. C. HARDER.
Okla. Gas & Elec. Co.
Oklahoma City, Okla.

A Question For Our Readers

WE ARE planning to install a 50-ton ice plant, the machine to be driven by direct-connected oil engines. The demand varies and we would like to know the better choice: two compressors driven by two engines, or a single machine driven by one engine which at times of low demand will be run at half speed. C.F.X.

Suitable answers from readers will be paid for and published in the April 23 issue.

Steam Generation at HIGH PRESSURES *and Temperatures*

II. The Loeffler Boiler

BY PROF. DR. ST. LOEFFLER
Technische Hochschule, Charlottenburgh, Germany

In the March 19 number of *Power*, Professor Loeffler discussed the fundamentals of the use and generation of high-pressure steam. He also commented on various types of boilers used in high-pressure steam generation and pointed out what, in his opinion, are their weak points. This second and concluding section is devoted almost entirely to an explanation of the Loeffler "steam-pumping" boiler with descriptions of actual and projected installations and reports of results obtained. Readers are invited to discuss points brought out by Professor Loeffler in these two articles.

SINCE the beginning of 1924, the writer has been engaged in developing, first at the plant of the Wiener Lokomotiv-Fabriks-A.G. at Wien-Floridsdorf, and later at the Witkowitzer Bergbau-und Eisenhüttengewerkschaft of Witkowitz (Czechoslovakia) a method of generating high-pressure steam which may be termed the "steam-pumping process."

In this process, the heating medium is steam which, taken from the vaporizer (Fig. 1) and forced to circulate by the pump is superheated in a coil set in a furnace, and then blown into the water contained in the vaporizer. A portion of the superheated steam is led away to be used by the engine.

In starting the operation of the boiler, the free space in the vaporizer is filled once with steam at low pressure, and the circulating pump started either by steam or electric power. With the superheater in operation and the line to the engine shut off, temperature and pressure of the steam are gradually raised to the desired point. The higher the pressure of the auxiliary steam is at the start, the quicker will the boiler reach the working pressure. As soon as this has been attained, steam is admitted to the engine to be driven.

When a boiler is shut down only temporarily, as over night, enough pressure will be maintained in the well-insulated vaporizer to permit the boiler to be started without the help of auxiliary steam.

This point is well illustrated by the operation of the high-pressure boiler of the Wiener Lokomotivfabrik. Upon starting, about 40 atmos. (570 lb.[1]) of pressure were still in the vaporizer. Due to this fact, the running-in time required for attaining the working pressure of 110 atmos. (1550 lb.) was reduced to about ¾ hours.

If, in a plant comprising several boilers, one is already in operation, then another boiler may have its vaporizer filled at once with steam at working pressure, and the additional time required to get this boiler ready for work will only be a few minutes.

As with the Benson method, the steam-pumping process is a pronounced high-pressure process. With low pressures, say below 50 atmos. (700 lb.), it does not permit at all of economical operation.

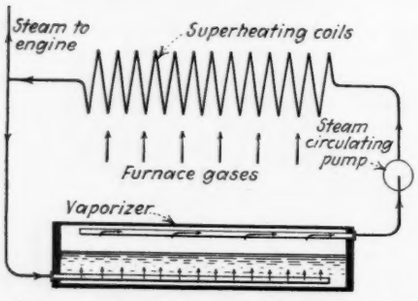


Fig. 1—Steam generation by the "steam-pumping" process eliminates water tubes in boilers

[1]The European "atmosphere" is 14.2 lb. per sq.in., equivalent to a pressure of one kilogram per square centimeter.

For pressures lower than about 20 atmos. (280 lb.) the circulating pump calls for more energy than the boiler is able to furnish. At 40 atmos. (570 lb.) the circulation still requires over 20 per cent of the total steam energy generated. The steam-pumping process is therefore economical only with pressures beyond 50 atmos. At 130 atmos. (1,850 lb.), which is the pressure for which the latest boilers are being built, the pump absorbs only two per cent of the total steam energy generated in the boiler.

Of importance is also the further fact that the energy demanded for steam circulation rapidly decreases with decreasing load. Fig. 2 shows the comparative figures for feed water and steam circulation at a normal operating pressure of 130 atmos. (1,850 lb.) under varying load conditions.

An important point in the steam-pumping process is that the bubbles of superheated steam in the vaporizer are bound to travel only through a few inches of water height, in contrast to the path of many feet length found in ordinary boilers, and that the steam bubbles yield only their superheat to the water. The steam therefore has a decidedly smaller chance of becoming sat-

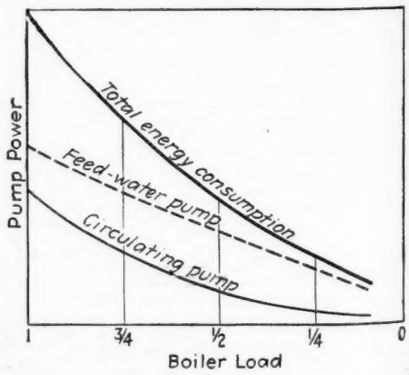


Fig. 2—Comparative energy consumption of circulating and feed-water pumps at a boiler pressure of 1,850 lb.

urated with moisture and impurities. It first enters the circulating pump, where the heat of compression is transmitted to it, and thus flows to the superheater in a dry state.

The steam-pumping process normally demands the forced circulation of high-pressure steam, which resembles water in that it is excellently suited to the reception of heat and which, by reason of its small specific volume, requires only a small amount of pumping energy for its circulation.

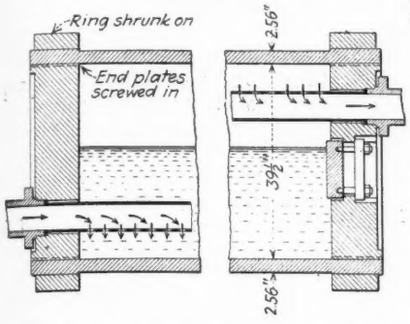


Fig. 3—Vaporizer of steam-pumping boiler

Steam permits of much easier uniform distribution through parallel heated tube coils than does water, especially when non-uniform steam formation in the water cannot be prevented, and when the water is not absolutely clean. The transmission of the fuel heat to high-pressure steam in superheater tubes guarantees an always constant heating efficiency and uniform steam generation, because the heating surfaces remain at all times clean, and because every change in the load and in the firing can be promptly balanced by regulating the steam volume circulated.

The deposition of boiler scale from the feed water in the vaporizer has no bad effect, and, when forming a solid coating, may even reduce radiation losses. In the preheater tubes, the formation of scale is prevented by the chemical cleaning of the water and by raising the speed of flow to usually over 0.5 meters (1.6 ft.) per second. No distilling equipment is required with a steam-pumping plant.

As long as steam is positively circulated, even a sudden cut-out of the entire load will not endanger the superheater coils, as it would be with ordinary boilers. It is only if, in addition, the steam circulating pump should suddenly stop that the superheater tubes might be damaged. A simple safety device, however, can be made to prevent any damage to the tubes in this eventuality.

The heat expansion of a straight piece of superheater tube exposed to the severest effect of the fire is used to open a blow-off valve whenever a predetermined tube wall temperature is exceeded. This causes the steam to escape from the vaporizer drums through the superheater tube coils into the open air, or into a space under lower pressure. At the same time, the fire is heavily throttled or shut off.

Material defects and even the bursting of a tube cannot cause any dangerous explosion, as can be the case for instance with water-tube or sectional boilers, because steam only can escape, this steam passing into the flues and finally putting out the fire. A simple check valve behind the superheater prevents the possibility of water escaping through a broken superheater tube.

The process of steam pumping may therefore be considered as embodying so high a degree of safety as to place it outside the scope of inherent official rules concerning the construction and operation of steam boilers. It would even be impracticable to apply the existing steel specifications to this case, for high-pressure boilers call for hard steels, whereas today soft grades of steel are still specified for the plates, tubes and other parts of ordinary boilers.

Hard, open-hearth steel does not under enduring stresses show any such rapid decrease of strength at the point of elastic limit as soft steel. Superheater tubes made from soft open-hearth steel with a tensile strength of 50 kg. per sq.mm. (70,000 lb. per sq.in.) at ordinary temperatures, have an elastic limit of only about 7 kg. per sq.mm. (10,000 lb. per sq.in.) at 550 deg. C. (1,000 deg. F.) and about half this amount if the stress is prolonged for any length of time. As against this, tubes made from steel with over 65 kg. per sq.mm. (93,000 lb. per sq.in.) tensile strength at normal temperatures show an elastic limit of about 11 kg. per sq.mm. (15,500 lb. per sq.in.) at 550 deg. C. (1,000 deg. F.), and this strength decreases but little with continued stress.

Hard steels only are therefore used in all parts of steam-pumping process boilers, the tubes for the later design being made as far as possible from steel with about 70 kg. per sq.mm. (100,000 lb. per sq.in) tensile strength and over, which still processes good autogenous welding properties. The tubes are joined either by threads, or preferably, by welding. It is necessary, however, to anneal the welded seams subsequently, the coils being introduced bodily into a furnace, while the final welds are annealed right on the spot for some distance on both sides of the seam by means of a welding torch or some similar special contrivance.

The vaporizer drums are also made from hard steel of a tensile strength of 50 to 70 kg. per sq.mm. (70,000 to 100,000 lb. per sq.in.). Fig. 3 illustrates one such drum, composed of a cylindrical shell with inserted end walls. The tubular shell is drawn or else, and in fact usually, forged from a solid billet and rough-turned on both the internal and external surfaces before the ends are put in place, in order to permit

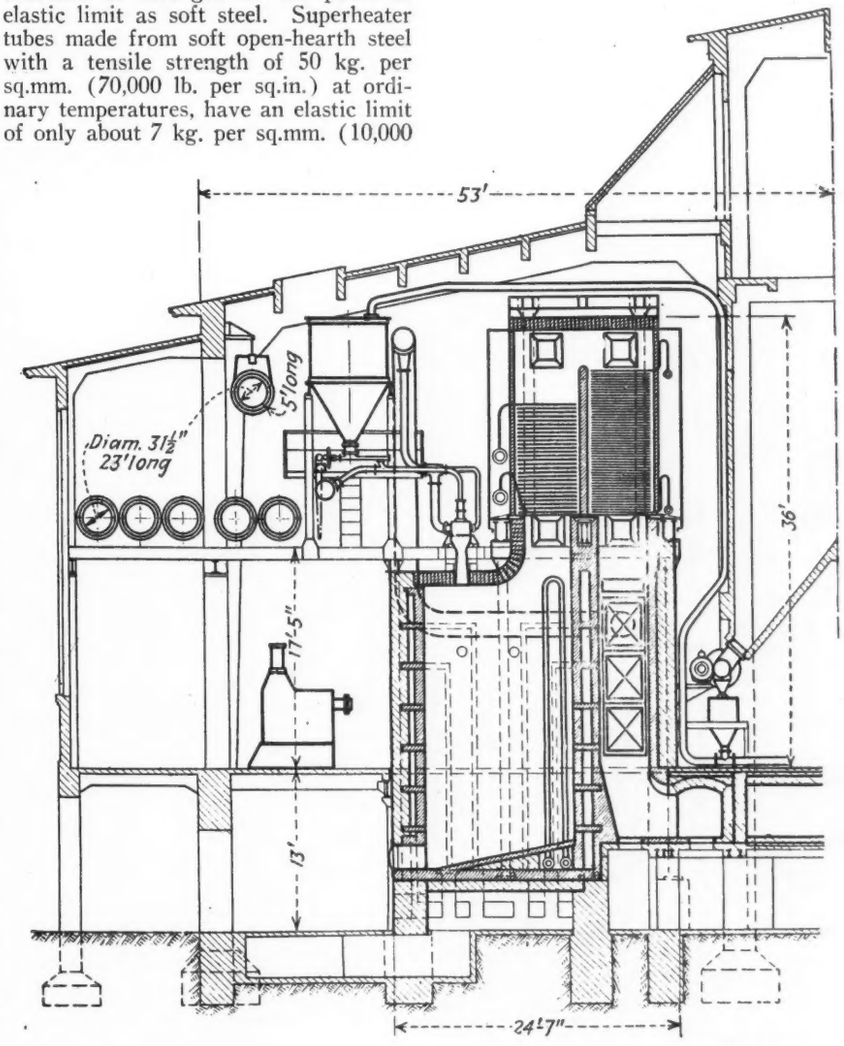


Fig. 4—Arrangement of first Witkowitz boiler for 120 atmos. (1,700 lb.) maximum pressure and 500 deg. C. (930 deg. F.) maximum temperature

the discovery of any defects in the material. It might, however, be produced by welding heavy steel plate, since in service it is exposed only to the stresses caused by the pressure and temperature of saturated steam.

As there are no perforations for tubes, the wall thickness can be kept comparatively small. With an inside diameter of 1,100 mm. (43.5 in.) a wall thickness of 65 mm. (2.56 in.) is required for 140 atmos. and 340 deg. C. (2,000 lb. and 650 deg. F.). Where light weight of the drum is of importance, as for instance with locomotives, alloy-steel plates of considerably smaller thickness may be used without any appreciable increase in first cost.

The end plates are screwed into the shell, which is shrunk on them, a ring then being shrunk over the joint to counteract the strain set up. The pipes for taking the steam to and from the drum, for feed water, for water-level gages, etc., are flanged to the ends. A manhole provided in one of the end plates gives convenient access to the interior for placing the perforated tubes as well as for any later cleaning. Drums made in this way are safer and cheaper than the one-piece forged steel drums of ordinary high-pressure boilers with their numerous perforations in the cylindrical shell.

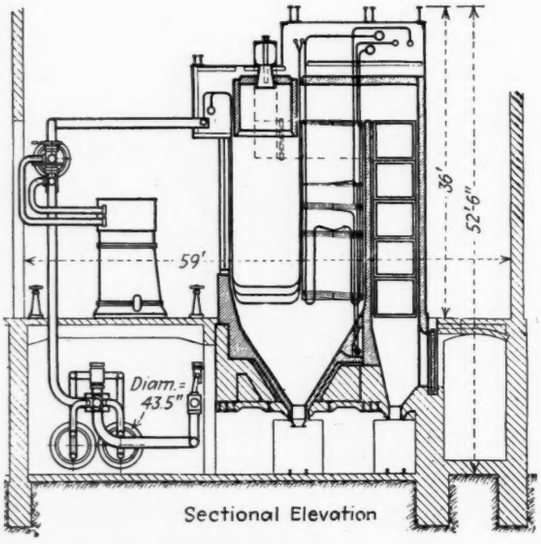
Fig. 4 is a vertical section through the first Witkowitz boiler, of a capacity of 15 tons of steam per hour at 120 atmos. (1,700 lb.) and a maximum temperature of 500 deg. C. (930 deg. F.). This boiler is fired with powdered bituminous coal, nearly all of the air of combustion, preheated to 300 deg. C. (570 deg. F.), being mixed with the coal in the burner, and only a small part previously diverted and used cold to convey the powdered coal from the bunker to the burner.

Originally, a combustion chamber completely lined with firebrick only was planned. Shortly before the erection of the boiler it was decided to place a part of the superheater, in the form of U-shaped tubes issuing from horizontal headers below, along the rear wall in order to test the durability of such a superheater.

Part of the combustion gases are carried through ducts in the brickwork and finally introduced through small openings into the combustion chamber, a very effective cooling of the walls thus being obtained. This cooling, together with the heat absorbtion of the radiation superheater, suffices to chill the ashes completely into the granular state without the aid of a water-screen grate. The ashes are deposited at the lower end of the superheater as granular matter free from lumps.

In the Witkowitz boiler, five vaporizer drums of 800 mm. (31.5 in.) internal diameter and 7 meters (23 ft.) length are arranged in parallel. This construction was chosen to permit observation of the behavior of parallel vaporizers under different conditions of load and flow, it being evident that larger-capacity boilers will call for the installation of several vaporizers. Ordinarily a single drum would be sufficient for a boiler of such a small size.

Grave fears have often been expressed in regard to steam circulating pumps, and they have been looked upon as a disagreeable part of the new process, mainly perhaps because of the need of high-pressure stuffing boxes. In taking such a view, the fact is overlooked that these pumps only have to produce a moderate increase in pressure in a very harmless and almost agreeable medium, namely saturated steam, and therefore can be made decidedly more dependable in operation than, for instance, high-pressure feed water pumps, which have to move hot water, or high-pressure compressors, which in the chemical industry today are operated at pressures of up to 1,000 atmos. (14,000 lb.).



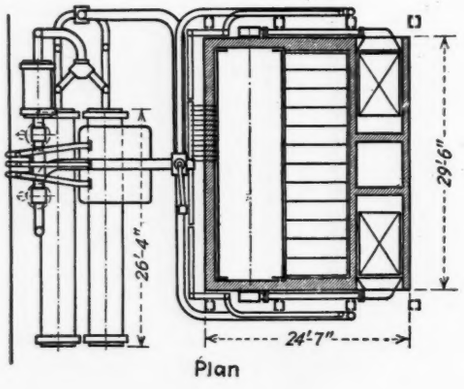


Fig. 5 (Left)—Loeffler boiler of 50 tons per hour steam capacity, for 130 atmos. and 4,800 deg. C. (1,850 lb. and 900 deg. F.)

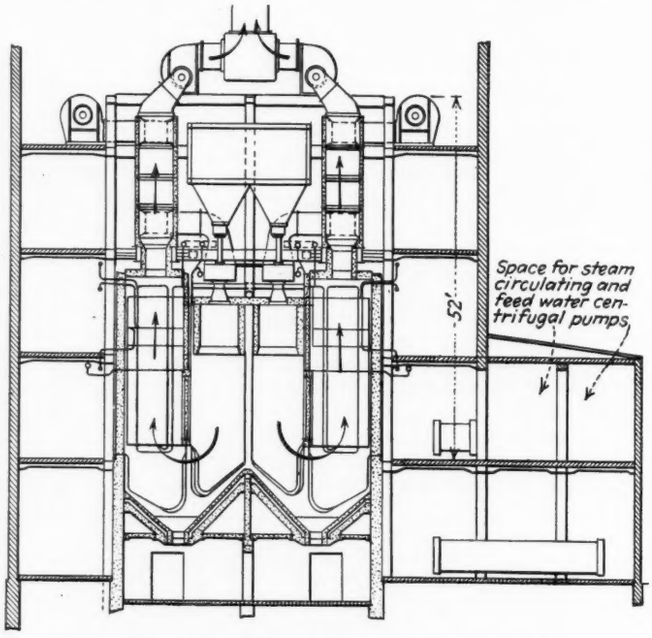


Fig. 6—Loeffler boiler of 155 tons per hour steam capacity for 140 atmos. and 500 deg. C. (2,000 lb. and 930 deg. F.)

The stuffing boxes may be made entirely and reliably tight either by the use of coiled soft packing, or better, by means of split-ring metal packing.

In driving the pumps from a low-pressure steam engine, the steam required may be bled from the main engine, similar to the procedure followed for feed water preheating. The exhaust steam of the pumping engines is utilized in preheating the feed water, and as this steam also carries with it the friction-heat produced by the steam circulation, no loss of heat results in this connection.

The power required by the circulating pump might be reduced by about 30 per cent if the steam for the main engine were taken directly from the vaporizer and superheated separately. By doing this, however, appreciable complications

would be introduced into the regulating of the operation. By circulating the operative together with the heating steam. moreover, a very nearly constant superheat temperature is obtained even under large fluctuations in load, a circumstance of great value from the point of view of the dependability and the flexibility of the engine operation.

From what has been said, as well as from the general characteristics of the steam pumping apparatus, it will also be clear that the heat value of the coal is transformed into steam heat with an efficiency at least equal to that of other boilers, since it can be utilized almost entirely for producing steam. Already the small Vienna boiler showed efficiencies of over 80 per cent when driven at sufficiently high preheated air temperatures, that is from 130 deg. to 150 deg. C. (265 to 300 deg. F.).

The radiating surface of the boiler can ordinarily be made smaller than with boilers of the usual types. Apart from this, large amounts of steam can be produced by a single boiler, so that steam-pumping process may be made to combine small space requirements with low first cost and high economy of operation.

Triple Feed Pumps

With new boilers for smaller output, piston pumps are to be used if possible, with three cranks spaced 120 deg. apart, direct connected to a low-pressure steam engine. The pumps will be equipped with automatic plate valves in order to secure a simple and compact construction. For larger boilers, centrifugal pumps may be employed with sufficiently good efficiency. Such pumps are therefore contemplated for the first time with the new high-pressure boilers of 40 tons normal and 50 tons maximum hourly output for the power plant of the Witkowitz coal mines.

The general arrangement of such a boiler may be seen in Fig. 5. The combustion chamber is lined with U-shaped superheater tubes. At their lower ends, these leave large passages for the furnace gases, which pass over a secondary superheater and a water preheater, composed of parallel tube coils, in the first flue, and over an air preheater in the last flue. Refractory lining is to be used as little as possible in order that the generation of steam may respond rapidly to variations in firing.

The two vaporizer drums of 1,100 mm. (43.5 in.) internal diameter and 8 meters (26 ft.) length are arranged below on the foundation, and therefore do not call for heavy supporting structures. Above the drums is seen the group of pumps, the drawing showing piston pumps of the original design. It will be seen that such a boiler, of 50 tons per hour maximum steam output, with all auxiliaries, can easily be accommodated within a space about 18 meters (59 ft.) wide, 15 meters (50 ft.) long and 16 meters (53 ft.) high.

A very important advantage of the steam-pumping process is the simple control and regulation of the superheat temperature, which is maintained constant even under large load fluctuations without the help of a superheat regulator merely by varying the volume of steam circulated. The superheat does not vary appreciably under changing load even when the pumping effect remains unchanged, since the steam operating in the main engine is taken from a many times larger volume in circulation.

Superheat Is Stabilized

This is of great value for any type of steam engine. With ordinary boilers the engine may easily receive wet and impure steam if, as is frequently done, water or wet saturated steam is mixed with the superheated steam for the purposes of regulating its temperature. This is, indeed, one reason why, in ordinary boilers, the normal superheat temperature is maintained at a moderate figure and does not, for instance, exceed 400 deg. C. (750 deg. F.) in the latest American high-pressure boilers.

It is only with high superheat, however, that the chief advantages of high-pressure steam can be realized. Because of this, the superheat temperature was raised to 500 deg. C. (930 deg. F.) in the very first steam-pumping plant erected. Yet no high-grade steels were used in the superheater tubes, because of the dependable control of the superheat afforded by this process. It is therefore entirely possible that even higher operating temperatures may be attained with this process through the use of higher grade superheater tube material.

With ordinary boilers, it is necessary to be cautious in increasing the working steam temperature, since occasional rises cannot be positively prevented.

Adaptability to Space

The main constructional advantage of the new steam generator is its ready adaptability to given space proportions in height, depth, and width, due to the fact that it practically consists only of tube coils and that the vaporizer drum may be located in any convenient manner. It also lends itself to manufacture on a production basis for various outputs, as it can be assembled of standardized tube coils, drums and fittings.

Before being started first in service, a steam generator of this type may be subjected to a cold-water pressure test at several times the working pressure; thus permitting any existing material defects to be readily ascertained. With the customary boiler types on the other hand, the test pressure may not appreciably exceed the operating pressure, because the boiler joints might suffer and excessive stretching might result, the detrimental consequences of which frequently become apparent only later in service.

Fig. 6 shows the general arrangement of a steam-pumping boiler with the very considerable steam output of 155 tons per hour. There will be seen the extraordinary small space requirement of such a high-pressure boiler. With this construction there is no apparent limit to the possible size of a boiler.

Eye Protection in Welding

The following comments on eye protection in welding are taken from the bulletin, "Safety in Welding," prepared by the Policyholders' Service Bureau of the Metropolitan Life Insurance Company, New York City.

Welding processes may be placed in two groups as far as the effects of radiant energy are concerned.

1. Processes requiring only a moderate reduction of visible radiant energy, such as oxyacetylene and oxyhydrogen welding and cutting, and electric resistance welding.
2. Processes necessitating a large reduction of visible radiant energy—electric arc welding and cutting.

For the protection of eyes from ultra violet rays, black, amber, green and greenish yellow glasses are best, especially greenish yellow.

For protection against infra red rays, deep black, yellowish green, sage green, bluish green and gold plated glasses are best.

For intense radiance the darkest glasses possible should be used; black, green and yellowish green, as these not only cut down the light, but protect from both ultra violet and infra red rays.

The *National Safety Code for the Protection of the Heads and Eyes of Industrial Workers* specifies that for the first group goggles, face masks, helmets and shields are permitted. The goggles may be of the rigid, non-adjustable bridge type, with or without side shields, or with flexibly connected lens containers shaped to conform to the face. In either case, a heat insulating material should be used on all parts that touch the skin to avoid burning. Goggles should be made of material capable of being cleansed and sterilized.

Face masks or helmets of standard type may be used. Regardless of type of goggle or shield, the lenses should not transmit more than 1 per cent of radiant energy of any wave length less than 406 millimicrons, and not more than 50 per cent of the total radiant energy from the standard source.

For the second group, only the helmet or the hand shield are permissible, as goggles do not give sufficient protection. The lenses should transmit not more than 1 per cent of the radiant energy of any wave length less than 406 millimicrons, not more than 1 per cent of visible light, and less than 10 per cent of total radiant energy.

In all welding operations, particularly where the electric arc is used, care must be taken to protect the welder from reflections of the arc from side walls, and *persons working near-by* must be protected. Where welding is done routinely indoors, booths should be provided for each welder.

In using the electric arc, care must be taken to prevent the skin from being burned, as the arc is very rich in ultra violet rays. Hence, the necessity for a helmet or shield to protect the face as well as the eyes, and high gauntleted gloves of non-inflammable material to protect the hands, and no part of the skin should be exposed.

Training and Management of

WELDING OPERATORS

for Pressure Piping, Tanks and Vessels

By H. H. Moss

Development Section, Engineering Department,
The Linde Air Products Company

SPECIFICATIONS for and management of welding in construction are no different from those required for other methods of construction. In any case proper plans and specifications are essential to a satisfactory result. In their development the executive concerns himself only with the translation of the requirements for the job; he seldom bothers about the details employed in their production. Such matters are generally left to the judgment of those responsible for their production. Through competent inspection he is assured that his requirements are fulfilled.

In the case of welding the same steps are applicable and will produce satisfactory results if the requirements upon the welding organization have been properly determined for the service to which the welded part will be subjected.

To make these determinations, the average executive feels that he or his engineering staff should have considerable practical welding experience, and many attempt to keep informed on the actual production of welding, its technique and its many special characteristics.

The average man, however, has neither time nor opportunity to do this. It requires careful consideration of the many factors involved in welding procedure control, and this is no simple matter. In the first place, should he undertake a proper study of construction welding, he cannot proceed very far before he finds that in many instances different authorities on welding offer different solutions for welded construction of the same class.

The result often is that he either refers his welding problems to one or more authorities on welding in the field in which he is working or, as frequently happens, defers the use of welding until he has time for the proper study and determination of suitable welding designs and construction procedures.

Calling in consultants until such time as his own organization has attained proper knowledge of welding is certainly to be recommended, and consulting engineers should fit themselves to advise properly in this regard. Unfortunately, there are many cases where welding is not considered because of the inability of an executive to give it his personal attention, so that the many advantages of the welded joint, such as its higher strength, its possibilities for weight economy, lower first cost, lower maintenance cost, etc., are not realized. If welding is not understood as a construction method, its outstanding advantages in making alterations and repairs are probably not utilized either.

How can one tell when a weld is sound? This question, frequently asked, implies that the problem of good workmanship in the welding field is fundamentally different from that in other fields of construction. This article, an abstract of a paper recently presented before a combined meeting of the Metropolitan sections of the A.S.M.E. and the American Welding Society, shows that it is merely necessary to apply established methods of training, testing, and control to insure sound welds.

Today we cannot question the ability of welded construction to meet requirements that operating service demands, particularly where lower carbon steels are used. There are countless precedents that point to the suitability of welding in pressure vessel, piping and structural work, both based on jobs done and on major research work. The application of welding in the gas and oil industry, where the need for strong, tight joints has resulted in a study of welding and use in almost every direction, shows to other industries what they may accomplish.

The question is, and one that logically suggests itself, what standard and simple means are there available to engineers by the use of which they can be sure of obtaining satisfactory welding for their construction, similarly as they do with other methods of fabrication?

Before going into the solution, let us consider for a moment the recourse of executives with regard to the determination of adequacy of other parts of their construction than welding to meet certain operating requirements, and see if we cannot deal with the welded part in a similar manner. A welded joint is a part of our construction, just as any other joint or assembly of material is a part of it.

For illustration, take the matter of valve, flange and fitting materials for high-temperature service. Your specification will in most cases properly refer to A.S.M.E. Boiler Code Specifications covering these materials. These code specifications will state that the castings shall conform to a certain chemical composition, and the manufacturer is called upon to specify the limits they will accept as a basis for rejection. A ladle analysis and check analysis are demanded.

Certain physical requirements are set up and many other detail checks are provided to insure serviceable material. Heat treatment is properly covered. Any castings that do not conform to these specifications or that show injurious defects are promptly rejected by your inspector. Bolts and nuts are given similar consideration. The same is true for materials for piping and pressure vessels.

In a piping specification, for instance, we require conformity of materials to definite specifications for the following factors: Process of manufacture; chemical composition; tension tests; hydrostatic tests; flattening tests; bend tests; test specimens; number of tests; retest; standard weights; permissible variations; lengths; workmanship; ends; finish—all in all, a rather stringent specification.

Again, in the matter of flanged joints for piping, we generally explain in our specification just how they shall be made up by the fitters or manufacturers, and frequently make trade references to emphasize the quality of the product.

If dealing with special materials or alloys whose specifications are not reduced to standards, we are careful to specify in detail the properties and methods of evaluating their properties in order to insure adequacy to the service in which they will be utilized.

For all these specifications there is a co-factor—namely, design—which provides for the proper application of the materials. Inspection is introduced, and upon this we depend for the satisfactory carrying out of the design and specifications.

The solution of a problem where welding is contemplated can be made in the same manner. It requires consideration of the factors that make up welding procedure control, wherein is contained the factor that deals with production of the weld, or, as we are more or less prone to regard it, the "human element" in welding. If we look upon this problem in the same manner in which we regard it for other methods of fabrication, we can simplify it.

First, let us draft a key or list of factors to be dealt with which might be developed as follows:

A. Materials for welding.
B. Design for welding.
C. Qualification of welders.
D. Final testing.

One very important step in procedure control is omitted in this list—namely, shop practices—because it is generally difficult to specify such things as methods of clamping parts together, spacing to be allowed, etc. In a shop where the personnel is experienced, as is demonstrated by their having done satisfactory work, these practices have been taken care of.

Under the heading of "Materials for Welding" we have two materials to consider—the base metal and the welding rod.

"No specifications call for tests of the strength of riveting, yet there are distinct variations in quality of riveting with regard to such things as punching or drilling holes, alignment, reaming and full-sized rivets. In other words, workmanship is a distinct factor."

Both may be specified, as for other types of fabrication, by

1. Chemical analysis.
2. Physical test for strength.
3. Physical test for ductility.
4. Process of manufacture.
5. Etc.

And the rods may have additional tests for weldability and for strength of deposited metal.

To simplify matters, quality of base metal can be called for to comply with suitable A.S.M.E. specifications or American standards. Rod specifications can be called for in suitable standards that have been developed.

Frequently, a selection must be made from several types of base metal and several types of rod. The needs are the controlling factors, except that it should be remembered that the highest quality is usually the best in the long run. But this is not different in principle from that for riveted construction or flanged pipe installations where the type of material must be specified.

Design for welding, which will result in the joint being made at the most suitable place and of the most suitable type, should be handled by some trustworthy engineer or draftsman who is familiar with welding requirements. This is really much simpler than for other types of construction. A little aid may be useful on the first job or two, but such aid can be readily obtained today by the executive who desires to use welding.

It is much less difficult to choose between the butt-weld type made from two sides, a single-Vee butt weld, a double-fillet weld or a single-fillet weld, than it is to select and lay out the correct riveted design between such extremes as quadruple double butt and single lap rivet.

Standards of strength for the several types of welds with different quality materials may be obtained from the welding industry in a few hours or minutes, and then what is called for is welding performance by the welding organization in actual construction. It is relatively easy to obtain welds that will consistently average above the minimum strength of flange-quality steel and thus develop in the joint the full strength of the material.

Under the very important heading, "Qualification of Welders," we find an addition to fabrication specifications. No specifications call for tests of the strength of riveting, but there are distinct variations in quality of riveting with regard to such things as punching or drilling holes, alignment, reaming and the use of full-sized rivets. In other words, workmanship is a distinct factor. The inspection for workmanship and the final test are expected to take care of this matter.

To be reasonably sure of performance the executive specifying welding should require a qualification test of each welder who will be allowed to work on the job. A certified test on similar material made within a specified time should be employed, but a good test on, say, $\frac{3}{16}$-in. material would not qualify a welder for work on a $\frac{1}{2}$-in.-thick plate, let alone $\frac{3}{4}$-inch.

Of the various tests possible the ductility test is one of the simplest and most valuable. This test requires that the coupons be clamped in a vise with the edge of the weld in line with the top of the vise jaws, in which position the exposed section of the coupon shall be gradually rotated in either direction until the section is bent through an angle of not less than 90 deg. Under this test the weld shall not develop any visible surface cracks or fractures.

It is necessary of course, where fillet welds are used, to provide a test specification that utilizes this type of weld. A collar or bell-and-spigot joint is called for and upon completion of welding, cross-sections of the fillet are inspected for fusion and penetration. The strength of fillet weld metal is generally determined by testing a butt weld made by the same welder. However, a tensile specimen having fillet welds can be easily made up.

Some very interesting recent test results of both the butt and fillet welds on piping are reported in the American Gas Association 1928 Report of Subcommittee on Pipe Joints, covering pipe sizes from 4 to 8 in. inclusive. From these data suitable specification design data could be readily obtained.

"To sum up the situation under procedure control, the present-day executive can have welding specifications drawn up so as to check each step in welded construction and place the responsibility for trouble where it belongs should the final test not be met."

When a welder fails to pass a good test, it frequently means that he is not well advised as to correct penetration and the correct amount of heat to use. A very short period of instruction under a competent man will generally be ample. But qualification tests have proved to be the best trainers of welders because the results put it up to the men.

By the use of exacting qualification tests the burden of training is placed on the welding operator himself. In plants or in organizations where considerable welding is done, mechanics and men of other mechanical trades, as well as helpers who take an interest in welding, are often permitted, after they become fairly proficient by practice and elementary instruction, to do the less important work. These men, if they show sufficient proficiency to indicate an adaptability to welding, are frequently coached until it is possible for them to pass the required qualification tests for production welding. No such man should be permitted to work on specification welding until he is able to pass the qualification test demanded, however, and it is an important matter for the inspector to see that this provision is rigidly enforced.

One of the most important points for the management is the final test. If inspectors have seen that the various steps called for in good specifications have been followed, then the final test should insure that the job is going to give satisfaction. The type of test that will be a proof test should be given thorough study.

Upon completion of any welded vessel or piping it is customary to test hydrostatically to three times the working

pressure for weld strength. Subsequent air tests at reduced pressures can be made if desired. For piping systems 1½ times the working pressure is frequently considered sufficient, and quite often in steam lines the safety valve blowoff pressure is taken. Headers and special pipe fittings are generally tested to three times the working pressure.

For inspection of welding, if the organization does not have a qualified inspection staff, there are several commercial testing laboratories fitted to render this service. Furthermore, several of the larger labor schools of companies interested in the promotion of welding will gladly aid in training employees of purchasers of equipment so as to obtain satisfactory shop inspection.

To sum up the situation under procedure control, the present-day executive can have welding specifications drawn up so as to check each step in welded construction and place the responsibility for trouble where it belongs should tbe final test not be met.

This is exactly what he does with other methods of fabrication where he calls for certain results to be proved by test. He doesn't worry about correct practices because he provides inspection to see that specifications are carried out.

The era of correct management of welding is practically with us now.

RECENT PUBLICATIONS

POWER PLANT INSTRUMENT DATA BOOK. Published by the Brown Instrument Company, Philadelphia, Pa., 1929. Paper; 8 x 10½ in.; illustrated; 54 pages. Sent free on request.

THE purpose of this book is to provide data from which a suitable plan of instrument equipment, covering most operating needs, may be easily worked out for any steam plant. A chart is included that shows 105 places about a modern steam plant where instruments may be used. These include applications of instruments for the measuring of temperature, pressure, CO_2, machine speeds, liquid levels and quantities. Electrical measurements are not considered.

In test work the applications of instruments vary somewhat from their use in operation. In this book the functions of the various applications cited are presented from the viewpoint of operation. Although the applications are primarily considered from their utility in large power plants, most of them could be similarly applied with proportionate benefit in the plant of average or even small capacity. For those interested in improving their power-plant operation, this book contains many helpful suggestions.

THE POWER MONOPOLY.—ITS MAKE-UP AND ITS MENACE.—By Gifford Pinchot. Published by the author, Milford, Pa., 1928. Paper, 6x9 in., 256 pages.

WHETHER or not one agrees with the deductions made by the author of this book, the facts upon which they are based are of interest and value to engineers in the central-station field.

The work consists mainly of an alphabetical list of 4,362 companies in the power utility field, showing the holding companies, banking groups or other interests with which these concerns are affiliated. There is also a somewhat detailed study of the financial structure, executive personnel and organization of 166 holding companies and similar concerns.

These tabulations show that 41 big holding companies control 82 per cent of the electric utility business of the United States and that 35 of these companies are under the control of six banking and investment groups. These six groups, through the 35 companies, control about 64 per cent of the country's electrical power and serve about 68 per cent of the population.

The author calls this monopoly. The reviewer cannot agree with him. Think of the steel industry. In it six producers control more than two-thirds of the output. Think of heavy chemicals —the same can be said of that industry. No, while there are still six healthy competitors in the utility field, the only monopoly that will exist is the franchise monopoly that has always obtained.

But if one does not agree with the author's conclusions, the tables will prove valuable. Those who want to know where a company is located, or the profits of a certain holding company, or similar facts, will find the book a convenient reference.

HANDBOOK OF HYDRAULICS. By H. W. King, Professor of Hydraulic Engineering, University of Michigan. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City, and 6 & 8 Bouverie St., E. C. 4, London, England, 1929. Flexible; 4½x7 in.; 129 tables; 143 illustrations; 523 pages. Price, $4.

THE first edition of this handbook was published in 1918. In this, the second edition, the text has been rewritten and revised and much new material added. The new edition contains about 100 pages and 17 tables more than the old one. A new chapter on critical depth and hydraulic jump, including tables for solving the more important formulas, has been added. The chapter dealing with natural stream flow contains much new material and that treating of methods of measuring water flow has been extended. Some of the material, including a few of the tables in the first edition, has been omitted in the second.

In the first edition the adoption of the Manning formula was advocated for open channels. In the new edition its adoption as a general formula applicable to both open channels and pipes is recommended. In the chapter on open channels one of the tables added gives the elements of experiments for the determination of retardation factors in Chezy, Kutter, Manning and Bazin formulas, as obtained from 269 channels or parts of channels.

There are eleven chapters, which cover hydraulic units; hydrostatics; orifices, gates and tubes; sharp-crested wires; wires not sharp-crested; pipes; open channels; critical depth and hydraulic jump; measurements of flowing water; natural streams; and tables. This book contains a wealth of material, much of which has been presented in table form and should find a wide clientele among practicing hydraulic engineers and students.

RESETTING VALVES TO CHANGE FROM CONDENSING TO NON-CONDENSING OPERATION.—*What changes should be made in the valve setting of a Corliss engine if a change is made from running condensing to non-condensing?*

A. C. H.

When running non-condensing the exhaust will be at a higher pressure, and for smooth running of the engine the necessary cushioning on the exhaust can be obtained by less compression, obtained by closing the exhaust valves later in the stroke.

On a single-eccentric engine, set the eccentric back on the shaft so that only the necessary compression of exhaust is obtained, and see that the exhaust-valve rods are short enough to obtain release before the end of the expansion stroke. Setting the eccentric backward will delay admission and the steam-valve rods will need to be shortened so the valves will have less lap and proper lead.

With the wristplate hooked in gear, place the engine first on one center and then on the other, and adjust the valve rods to suitable lengths for obtaining the proper lead and release. With a double-eccentric engine, setting of the steam eccentric and steam valve gear needs to be no different than when running condensing, but for less compression of the exhaust the exhaust eccentric and exhaust-valve gear would require the same attention as the valve gear of a single-eccentric engine.

"Safety in Welding," the most recent industrial publication of the Metropolitan Life Insurance Company, is based upon the study of welding practices and presents the outstanding health and accident hazards involved with suggestions for overcoming them. Those interested in safety in welding may obtain copies of the booklet without cost by addressing the Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Avenue, New York City.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Power and Industrial Conference to be Held at Iowa University

UNDER the auspices of the College of Engineering, College of Commerce and Extension Division of the University of Iowa, a Power and Industrial Conference will be held at Iowa City during April 2, 3 and 4. The purpose of the conference is to provide a forum for the discussion of power resources and utilization, and the industrial development of Iowa.

Several of the papers presented at the meeting will be of special interest to power engineers. At the opening session, Tuesday morning, H. L. Olin, associate professor of Chemical Engineering, will give a paper on "Progress in Research on Use of Iowa Coal," and a paper on the "Developments in the Power Situation," will be presented by Joe Carmichael, Director of Public Utility Information, Des Moines.

In the afternoon the present coal situation in Iowa will be discussed by George Heaps, Jr., president of the Iowa Coal Operators Association; L. R. King, assistant general manager, United Light and Power Company, Davenport, will present a paper on "Availability of Electric Power for Industrial Development."

Other papers of interest will be "Relation of Power Utilization to Production," by Arthur Huntington, engineer, Iowa Railway and Light Corp.; "Industries to Which Electric Power Is Adapted," by J. T. Rood, professor of electrical engineering; "Industrial Loads, Present and Future, in Iowa," by R. D. Hayes, power engineer, Interstate Power Company, Dubuque; "Power Loads and Industry in Des Moines," by Chas. C. Clark, superintendent electric distribution, Electric Light Company, Des Moines, and "Industrial Development and the Public Utilities," by C. C. Heisterman, industrial development engineer, Public Service Company, Chicago.

It has also been announced that a Power and Industrial Show will be held at Memorial Coliseum and Hotel Tallcorn, Marshalltown, Iowa, June 5 to 7, under the auspices of the Iowa Association of Power Engineers. A large and varied exhibit of appliances and a program of interest are being arranged.

Porter Elected Chairman of Engineering Foundation

H. Hobart Porter has been elected chairman of Engineering Foundation, joint research instrumentality of the Founder Engineering Societies, to succeed L. B. Stillwell, who has served since 1925. Mr. Porter is president of the American Water Works & Electric Company and of the Brooklyn City Railroad Company. He is chairman of the board of the West Penn Electric Company and vice-president of the Queensboro Gas & Electric Company, as well as a director in many other companies. He is a member of the division of engineering and of the executive committee of the National Research Council; of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers and the American Society of Civil Engineers. He is a trustee of Columbia University, from which he was graduated in 1886 with the degree of M.E.

Mr. Porter was born in New York City in 1865 and was engaged in mining engineering in Mexico and Arizona until 1894, when he became a member of the engineering firm of Sanderson & Porter, New York, with which he has since been identified.

National Power Show To Be Biennial After 1930

The National Exposition of Power and Mechanical Engineering announces its intention to hold this Exposition biennially beginning with the 1930 Exposition. The Eighth Exposition of Power and Mechanical Engineering, more briefly known as the National Power Show, will be held as planned in the Grand Central Palace, New York, during the week of December 2 to 7, 1929, as already announced.

The Ninth Exposition will be held there in December, 1930, the Tenth in December, 1932, the Eleventh in December, 1934, and thereafter upon alternate, even-numbered years.

A.S.M.E. Committee Sets New Standard for Pipe Flanges

In accordance with an announcement made in January by the American Society of Mechanical Engineers, in which it was stated that the Boiler Code Committee had under consideration the adoption of the new American Standard for Pipe Flanges and Flange Fittings, comments and criticisms thereon have been received and carefully considered by the committee. As a result the committee has decided to revise Tables A-5 and A-6 as they appeared in former editions of the Code and to make additions thereto which will correspond with the new Tentative American Standard for Steel Pipe Flanges and Flange Fittings.

On account of the limited space available in the Boiler Code for the inclusion of these standards, it has been found necessary to limit the matter to be incorporated therefrom to facing dimensions and other general dimensional data pertaining to the flanges only. The revised tables and specifications are printed in the March issue of *Mechanical Engineering*, the A.S.M.E. publication. These include a table of facing dimensions for five different pressure limits for flanges and two tables covering general dimensions of steel and cast-iron fittings for different pressure limits.

Men in the News

R. J. S. PIGOTT

who for three years was mechanical engineer with Stevens & Wood, Inc. and later consulting engineer with Public Service Production Company and Smoot Engineering Corp. has returned to the Stevens & Wood organization as consulting mechanical engineer.

For several years Mr. Pigott was chairman of the A.S.M.E. Main Research Committee and has had wide experience with industrial and power plants. In his capacity he will devote his time mainly to solving the problems of industrial companies both in matters of power and production

Ceramic Society Affiliates With Refractories Institute

Approval was given to the close affiliation of the American Refractories Institute with the refractories department of the American Ceramic Society, through the exchange of membership privileges and the consolidation of various activities at meetings of the two organizations held recently during the convention of the leading groups of the ceramic industry of the United States at the Stevens Hotel in Chicago.

The federation of the two associations is expected to presage a general movement toward unification, which will centralize chiefly the research activities of the industry and make for a reduction of waste and lost effort in perfecting modern methods of production.

Mechanical Engineers Wanted By Civil Service

The United States Civil Service Commission announces the following open competitive examinations:

Applications for the above-named positions must be on file with the Civil Service Commission at Washington, D. C., not later than April 24. The examinations are to fill vacancies in the Office of the Supervising Architect, Treasury Department, for duty in Washington, D. C., or in the field. Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience. Full information may be obtained from the United States Civil Service Commission, Washington, D. C.

N. Y. Edison Estimate Too High, Commission Finds

William McClellan, a consulting engineer and appointee of former President Coolidge to the Muscle Shoals Commission, submitted recently as the Public Service Commission's expert, his estimate of the reproduction cost of the property of the New York Edison Company, in the case of former Mayor Hylan against the company.

The case, a move by the city to affect a reduction in electric current rates, was instituted by Mr. Hylan more than five years ago with the filing of a complaint with the commission. Between the figures compiled by the Edison company and those of Mr. McClellan there exists a difference of $102,111,595. The company placed its estimate at $347,686,379, against $245,574,784 by Mr. McClellan.

The principal discrepancies found by the commission were in interest charges during construction, and in going value.

An item of $4,836,468 set by the company as the cost of gathering a vast collection of records, prints and maps, compiled since its beginning, was not allowed by Mr. McClellan on the contention that the cost of gathering these documents already had been put under the head of operating expenses.

THE EDISON ELECTRIC ILLUMINATING COMPANY *of Boston is contemplating the construction of a new steam plant at Everett, Mass., a few miles north of the Hub, to serve the north shore load, thereby obviating the necessity of transmitting power from the Edgar Station in Weymouth. The new station would have a capacity of several hundred thousand kilowatts, it is understood.*

* * *

DURING 1928 *the Society of Naval Architects and Marine Engineers presented to the United Engineering Society a portrait medallion of its former president, the late Admiral Stevenson Taylor. This memorial was placed in a hallway of the sixth floor of the Engineering Societies Building in New York City.*

* * *

ACCORDING *to the New England Bureau of Public Utility Information, all the ice sold in Boston is made artificially. From 27 to 45 kilowatt-hours of energy is needed to manufacture a ton of ice there, depending upon the time of year and other conditions.*

* * *

THE LEIPSIC TRADE FAIR *opened in Germany on March 4, and immediately became a record breaker in attendance and exhibits. An army of 200,000 buyers from 43 countries had arrived, and there were 10,500 exhibits of every conceivable industrial product. The mechanical exhibits alone numbered over 2,000.*

* * *

STEAM TURBINES *as power producers in industrial mills have begun to find favor in England. A paper recently given before the Bradford Engineering Society pointed out the economies that are already being realized by the use of turbines for power and process steam in the woolen, cotton and chemical industries.*

* * *

THE POTENTIAL RESOURCES *of the Tombigbee River in Mississippi are now under examination by United States Army engineers with a view to hydro-electric power development, improvement of navigation, land reclamation and flood control.*

* * *

BARCELONA, SPAIN *is to have an international exhibition of arts and commerce in May. One of the prominent features will be the exhibits centering around Spain's hydro-electric development. A potential total of 3,000,000 hp. has already been drawn upon to a considerable extent.*

* * *

THE SALUDA RIVER, *in South Carolina, is to be further developed according to a project planned at Lorick's Shoals, near Columbia. The initial installation will be for 30,000 hp., with an ultimate development of perhaps 75,000.*

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Big Wind Inn, Lake of Bays, Ontario, Can., June 27-29. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, annual meeting to be held in New York City, April 24-26. Secretary M. M. Kelly, society headquarters, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

PERSONALS

P. S. JONES, who was formerly manager of the Pittsburgh office of Cutler-Hammer, Incorporated, of Milwaukee, Wis., has become manager of the New York District office of that company.

J. A. PEARSON, vice-president in charge of purchasing, of the United Gas

Improvement Company, of Philadelphia, Pa., has tendered his resignation, to become effective April 1.

L. F. LANG has been made assistant to M. L. Cornelious, at the Cincinnati office of the Riley Stoker Corporation, to succeed E. H. Schmitz, who has been appointed to the Boston office of the company.

H. M. JONES has recently resigned from the Westinghouse Electric International Company, to accept a position as general manager of the International Power Company and vice president of the Montreal Engineering Company, Montreal, Can.

M. F. BEHAR, former advertising manager of the Tagliabue Manufacturing Company, has accepted a position in the same capacity with the Quigley Furnace Specialties Company, New York City.

F. L. A. SCHMIDT of the Cleveland district office of the General Electric Company has resigned to take a position on the power plant engineering staff of the H. K. Ferguson Company, also in Cleveland.

H. W. NEBLETT, formerly of the Neblett Engineering Company has joined the staff of D. H. Skeen and Company, which specializes in work for steel mills and similar industries.

BUSINESS NOTES

THE CARBORUNDUM COMPANY, Niagara Falls, N. Y., has opened a new edifice known as the New Carborundum Building, at 2759 East Grand Boulevard, Detroit, Mich.

THE ASHLAND FIRE BRICK COMPANY, Ashland, Ky., announce that they have joined the consolidation of several well known manufacturers of refractory products known as the North American Refractories Company. The headquarters are in the National City Bank Building, Cleveland, Ohio.

THE BLAW-KNOX COMPANY, Pittsburgh, Pa., makes an announcement of the merger of A. W. French Company of Chicago with Blaw-Knox and subsidiary companies.

THE VULCAN SOOT CLEANER COMPANY, Du Bois, Pa., is opening a New York office at 120 Liberty Street. This will be in charge of Mr. Linaker, who is vice-president of the company.

THE PREST-O-LITE COMPANY, INCORPORATED, New York City, opened its thirty-ninth acetylene gas plant at 925 Hughes Street, Houston, Texas, on Feb. 2.

THE WARREN STEAM PUMP COMPANY, INCORPORATED, Warren, Mass., announces the appointment of Garrett Burgess, Incorporated, 5050 Joy Road, Detroit, Mich., and the Hayes Power Equipment Company, 205 West Wacker Drive, Chicago, as representatives in the Michigan and Chicago districts, respectively.

With the Society Sections

A. S. M. E., Metropolitan Section. Meeting Apr. 1, in New York City. Subject: "Some Aspects of Corrosion in Steel Tube Economizers." Author to be announced. Meeting Apr. 11, Fuels Division, Subject: "The Heat Balance as a Means of Determining Evaporating Efficiencies of Steam Generating Equipment," by B. J. Cross, Combustion Engineering Corp.

A. S. M. E., Philadelphia Section. Meeting Mar. 26. Subjects: "Resume of High Steam Pressures as Used in Industrial Plants," P. W. Swain. "Twelve-hundred Pound Holland Station of the Pennsylvania and New Jersey Power System," by E. M. Gilbert, W. S. Barstow Management Association, Reading, Pa. Second Paper.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Florida Section. Meeting, April 10, at Jacksonville, Fla. Subject to be announced later.

Engineers Club of St. Louis. Meeting April 10. Subject: "Pumps and Pumping," by A. T. Hunter, De Laval Steam Turbine Company.

Second Annual Indiana Fuel Conference, at Purdue University, Lafayette, Ind., April 4-5.

TRADE CATALOGS

BOILERS — The Vereinigte Kesselwerke A.-G., Dusseldorf, Germany, has issued three four-page leaflets on boilers and boiler settings. There are illustrations showing installations and diagramatic sketches included.

STEEL PRODUCTS—A Buyers' Guide for Nickel Alloy Steel Products of the items most frequently inquired for has been put out by the International Nickel Company, Incorporated, New York City.

INDUSTRIAL FLOORING — "Floorgard" is the name of the strengthening mat of steel mesh which is made by the Blaw-Knox Company, Pittsburgh, Pa., for use in connection with concrete asphalt or other plastic floors. This is covered by a new twelve-page bulletin Form 1082.

WATER TURBINES—Aktiebolaget Finshyttan, Finshyttan, Sweden, has issued a new 72-page catalog under the title "Finshyttan Reaction and Impulse Turbines and Accessories." This piece of literature is published in English and describes the different classes of water-power equipment that the company builds, which included propeller-, Francis-, and impulse-type water wheels, governors, pressure regulators, pipe lines, gates, valves and couplings. Drawings show the general layout of a number of installations and several power, quantity and speed tables and other engineering data are a part of this catalog.

STEAM HEATING—The principles of a new application called the Webster Moderator System of Steam Heating, are briefly described in a four-page leaflet published by the Warren Webster Company, Camden, N. J.

VALVES—Jenkins Brothers, New York City, has issued a five-page illustrated folder, Form 132, descriptive of their special line of Fire Unlerwriters' Valves.

VALVES—"Seatless Valves" is the title and subject of Bulletin 8-T, published and illustrated by Schutte & Koerting Company, of Philadelphia.

BOILERS—An article entitled "The Boiler House in the Oil Refinery," by Walter Siegerist, has been reprinted by the Combustion Engineering Corporation, of New York. The publication is illustrated, and occupies eight pages. Copies will be sent on request by the corporation.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.40
Kanawha	Columbus	1.25@1.06
Smokeless	Cincinnati	2.15@ 2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.55@ 1.75
Gas Slack	Pittsburgh	1.00@ 1.15
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.00@ 1.50

FUEL OIL

New York—Mar. 21, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; 36@40 deg., furnace, tank-car lots, 6.25c. per gal.

St. Louis—Mar. 15, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.40 per bbl. or 42 gal.; 26@28 deg., $1.45 per bbl.; 28@30 deg., $1.50 per bbl.; 30@32 deg., $1.55 per bbl.; 32@36 deg., gas oil, 4.9c. per gal.; 38@40 deg., distillate, 5.98c.

Pittsburgh—Mar. 11, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.25c. per gal.

Philadelphia — Mar. 14, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 23@27 deg., $2.10@$2.16 per bbl.

Cincinnati—Mar. 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Mar. 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Mar. 18, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.52c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Mar. 16, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Berkeley—Bd. of Regents of University of California, is having plans prepared for the construction of a power plant on campus. Estimated cost $400,000. G. W. Kelham, 315 Montgomery St., San Francisco, is architect.

Calif., Sacramento—Pacific Gas & Electric Co., 11th and K Sts., plans to expend $1,022,200 for extensions and improvements to gas, electric and street car systems including new substation in southeast, extension of lines to station, also reconditioning station at A, 6th and H Sts. etc. Private plans.

Calif., Wheatland—City awarded contract for the construction of a sewage disposal plant and pumping station to G. DeGolyer, Bacon Bldg., Oakland. Estimated cost $35,186.

Conn., New Haven — Seamless Rubber Co., Hallock St., had plans prepared for the construction of a 32 x 55 ft. power plant. Estimated cost $40,000. D. E. Smith, 52 Temple St., is architect.

Conn., New Haven—United Illuminating Co., 84 Temple St., awarded contract for the construction of a power transformer station at Olive Court, to B. N. Blatchley Co., 902 Chapel St. Estimated cost $40,000.

Ill., Chicago—A. J. Epton, Room 837, 11 South La Salle St., will soon award contract for a 12 story apartment building, including central refrigeration plant at 1365 Hyde Park Blvd. Estimated cost $1,000,000. C. Shparago, Room 837, 11 South La Salle St., is architect.

La., New Orleans—Sewerage & Water Board, 526 Carondelet St., will receive bids until May 1 for the construction of drainage pumping station 1.

Me., Old Town — Water District Commission awarded contract for the construction of a pumping station and filtration plant to A. Bartington, 1 Washington St., Boston. Estimated cost $50,000.

Mass., Belmont—Bd. of Selectmen plans to vote $48,000 bonds for extensions and improvements to electric light plant. Engineer not selected.

Mass., Chatham—Bd. of Selectmen, plans the construction of a water system and pumping station. Estimated cost $25,000. Private plans.

Mass., Hopkinton—Water Dept., J. F. Sullivan, Chn., plans extensions and improvements to waterworks, including wells, pumping station, etc. Estimated cost $60,000. Engineer not selected.

Mass., Lowell—Lowell Ice Co., Inc., 30 Carney Sq., awarded contract for the construction of an artificial ice plant at 39-41 Middlesex St., to J. A. Simpson, 174 Central St. Estimated cost $200,000.

Mass., Provincetown — Provincetown Light & Power Co., H. F. McDonald, will build a power plant on State Rd. Estimated cost $40,000. Work will be done by day labor.

Mass., Watertown—Metropolitan Ice Co., 321 Washington St., Somerville, awarded contract for the construction of an ice plant here, to Vappi & Ferguson, 515 Massachusetts Ave., Cambridge. Estimated cost $40,000.

Mo., California—City plans an election about Mar. 22 to vote $60,000 bonds for the construction of an elecric light and power plant. Estimated cost $60,000.

Minn., Minneapolis—St. Barnabas Hospital, G. S. Grimes, Chn. Bd. of Trustees, 538 McKnight Bldg., awarded contract for the construction of a power plant, etc., at 6th St. between 9th and 10th Aves. S., to Field-Martin Co., 720 South 6th St. Estimated cost $200,000.

Mo., Meta — O. T. Brotherton, Kansas City, has made application to Missouri Public Service Commission, Jefferson City, for permit to construct an electric power plant, also transmission and distribution lines here. Estimated total cost $98,400.

Mo., Salem—City plans an election Apr. 2 to vote $25,000 bonds for the construction of an electric light plant, also distribution lines.

N. Y., New York—Corp., c/o L. M. Boomer, Waldorf Astoria Hotel, awarded contract for the construction of a 40 story hotel at Park Ave. between 49th and 50th Sts. to Thompson Starrett, 250 Park Ave.

Oregon—Portland Electric Power Co., F. T. Griffith, Pres., Electric Bldg., Portland, has made application for permit to construct a dam and reservoir, 100,000 acre ft. capacity on Clackamas River in Clackamas county. Estimated cost $3,000,000.

Pa., Easton—Easton Hospital, 656 Wolf St., will soon award contract for the construction of a boiler plant at Lehigh St. and Fairview Ave. Estimated cost $750,000. Ballinger Co., 105 South 12th St., Philadelphia, is architect and engineer.

Pa., Philadelphia — Philadelphia Gas Works, 1400 Arch St., will soon award contract for the construction of a power plant at 56th and Lindberg Sts. Private plans.

Tex., Point Isabel—Cameron County Water Improvement Dist. 11, c/o O. C. Dancy, County Judge, Brownsville, voted $500,000 bonds for an irrigation project here to include pumping equipment. V. L. Conrad, Brownsville, is engineer.

Tex., Sanderson — Texas, Louisiana Power Co., plans reconstruction of power plant to furnish light, ice and power for town and surrounding territory destroyed by fire. Private plans.

Tex., Sanger—W. E. Aston, Valley View, plans the construction of an electrically driven cotton gin, 5 stand 80 saw capacity. here. Estimated cost $35,000. Private plans.

Tex., San Antonio—T. V. Lawson, 326 Cumberland Rd., plans the construction of a 30 ton ice plant at 15th and Brook Sts. Estimated cost $30,000. Private plans.

Tex., Victoria—Central Power & Light Co., 300 Jones Ave., San Antonio, has made application for permit to Federal Power Commission to construct a power plant and dam, 35 ft. high and 480 ft. long on the Guadalupe River near here to develop 3,000 hp. Estimated cost $300,000. Private plans.

Wash., Tacoma—City will receive bids until Apr. 11 for the construction of a diversion dam, etc., on the north fork of the Skokomish river in connection with Cushman project unit No. 2. Estimated cost $3,000,000. 2

W. Va., Elkins—City voted $135,000 bonds for the construction of a municipal power plant.

Ont., Ottawa — Dept. of Public Works, Parliament Bldg., will soon award contract for the construction of a 4 story, 150 x 420 ft. research laboratory. Estimated cost $2,000,000. Sproatt & Rolph, 1162 Bay St., Toronto, are architects.

Equipment Wanted

Ice Making Equipment—Peoples Ice & Fuel Co., La Crosse, Wis., is in the market for ice making equipment for proposed artificial ice plant.

Motor—Tranquillity Irrigation Dist., J. S. Potts, Secy., Tranquillity, Calif., will receive bids until Mar. 28 for one 100 hp. electric motor type KT. 3 ph., 60 cycle, 2,200 v., 900 R. full load speed ball bearing with slide base and pulley.

Motors, Switchboards, etc.—Sewerage & Water Board, G. G. Earl, Secy., 526 Carondelet St., New Orleans, La., will soon readvertise for bids for four 2,000 hp. motors, three 1,200 hp. motors, nine truck switchboards, two motor generator sets, etc. Former bids rejected.

Pumping Unit—West Stanislaus Irrigation Dist., Westley, Calif., E. Smith, Secy., will receive bids until Apr. 6 for a vertical pumping unit consisting of 40 hp. pump and motor to deliver approximately 10 c.f.s. against 24 ft. head.

Pumps—City of Maud, Okla., deep well pumps, etc. for proposed waterworks improvements. Estimated cost $400,000.

Pumps, Etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., motor-driven centrifugal fire pumps, portable gasoline-engine driven pumping unit, etc. at Naval Radio Station, Jupiter, Fla.

Industrial Projects

Calif., Upper Lake—MILK CONDENSERY and POWER PLANT—Lake County Milk Products Corp., c/o A. J. Mazurette, 251 Kearny St., San Francisco, is having plans prepared for a 1 and 2 story milk condensery including power plant here. Estimated cost $125,000.

Ga., Atlanta—RUBBER FACTORY—B. F. Goodrich Rubber Co., South Main St., Akron, O., plans the construction of a factory at Hemphill Ave. and 14th St. Estimated cost $1,500,000.

Ill., Kewanee — STEEL PRODUCTS PLANT—Kewanee Mfg. Co., 401 Fremont St., plans the construction of a 1 story steel products plant at Division St. and Burlington Ave. Estimated cost $50,000. F. D. Chase Inc., 720 North Michigan Ave., Chicago, is architect.

Ind., Jasper—CHAIR FACTORY—E. C. Berendes, 108 McCurdy Bldg., Evansville, Archt., will receive bids until Apr. 8 for a 2 story, 300 x 300 ft. chair factory for New Indiana Chair Co., c/o architect. Estimated cost $75,000.

Mich., Detroit — CREAMERY — Risdon Creamery Co., 6525 Linwood Ave., awarded contract for a 2 story creamery and distribution plant to Krieghoff Co., French Rd. Estimated cost $100,000. Miscellaneous equipment including electric motors, etc., will be required.

Mich., Muskegon—DESK FACTORY—Shaw-Walker Co. awarded contract for a 5 story, 80 x 250 ft. factory on Washington Ave., to O. F. Miller Construction Co., Kalamazoo. Estimated cost $150,000. Sheet metal working equipment will be installed.

N. H., Laconia—FACTORY and BOILER PLANT—Scott & Williams Inc., 299 Union Ave., is having revised plans prepared for a 4 story, 65 x 185 ft. factory and boiler plant. Lockwood, Greene & Co., 24 Federal St., Boston, are engineers.

N. H., Redstone—GRANITE PLANT—Maine & New Hampshire Granite Corp., plans to rebuild cutting department unit and power house destroyed by fire. Estimated cost $200,000. Architect not selected.

O., Canton — TUBE MILL — Timken Roller Bearing Co., Dueber Ave., awarded contract for a 320 x 450 ft. tube mill to Warren Hoffman Co., 312 3rd St. N. W. Estimated cost $1,000,000.

O., Cleveland—AUTOMOBILE PARTS FACTORY—Thompson Products Co., C. E. Thompson, Pres., 2196 Clarkwood Rd., is receiving bids for a 4 story, 72 x 106 ft., addition to factory. Estimated cost $150,000. Roberts-Wright Co., Swetland Bldg., Archts.

O., Geneva—FORK and HOE FACTORY—American Fork & Hoe Co., G. B. Durrell, Pres., B. F. Keith Bldg., Cleveland, is having plans prepared for a 2 story, 40 x 200 ft. factory here. Estimated cost $40,000. C. B. Rowley, B. F. Keith Bldg., is architect.

Tex., Beaumont—OIL REFINERY EXTENSIONS and PUMPING PLANT—Magnolia Petroleum Co., 1009 Fannin St., Houston, plans extensions and improvements to oil refinery to include auxiliary pumping plant, cracking batteries, pipe stills, etc., here. Estimated cost $4,000,000. Private plans. Most of work will be done by owner's forces.

B. C., New Westminster — FURNACE and ROLLING MILL—Western Hardware & Steel Co., C. D. Hobbs, Granville Island, plans the construction of an electric furnace and rolling mill. Estimated cost $500,000.

Ont., Toronto — ELEVATOR FACTORY—Canadian Elevator Co., 24 Sherbourne St., is having plans prepared for a 2 and 3 story factory at Eastern Ave. and Heward St. Estimated cost $125,000. Ross & MacDonald, 1 Belmont St., Montreal, Que., are architects.

Ont., Walkerville — FACTORY — Bendix Corp., South Bend, Ind., plans extensions and improvements to factory here. Estimated cost $100,000.